FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

IN THIS ISSUE

Low Temperature, High Speed Rendering—The Kingan Process

Influence of Piece Size on Production and Quality of Dehydrated Irish Potatoes

Antioxidant Treatment for Bacon

Crumb Softness from Soy Fractions

The Volatile Content of Air in Commercial Apple Storages

Fat Injection of Beef Animal Parts

Air Purification for Apple Storages

Dehydrated Stabilized Egg. Importance and Determination of pH

The Influence of Vinegar Eels (Anguillula Aceti) on Vinegar Production

Relative Chemical, Functional, and Organoleptic Stabilities of Acidified and Glucose-Free Whole Egg Powders

Preparation of Stable Frozen Puddings

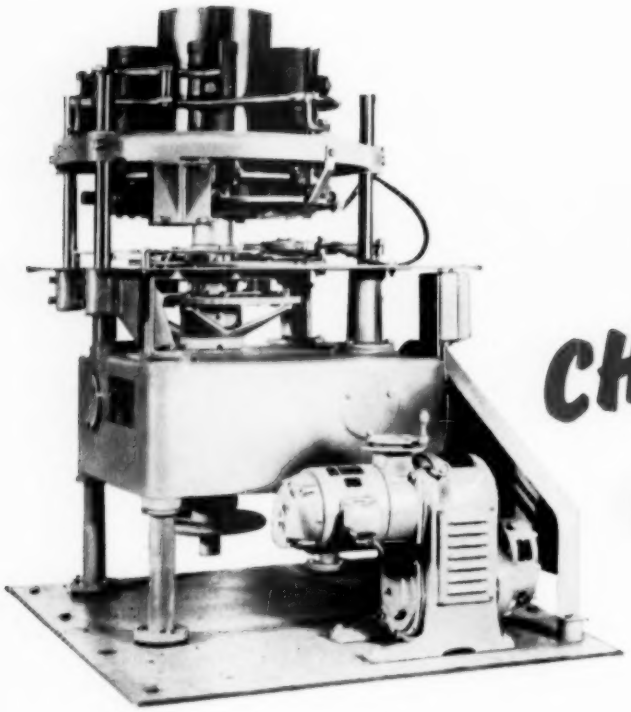
Observations on the Canning of Pacific Coast or Dungeness Crabmeat

Notes and Letters

Affairs of the Institute

Pages 421-468

November, 1953 Volume 7, Number 11



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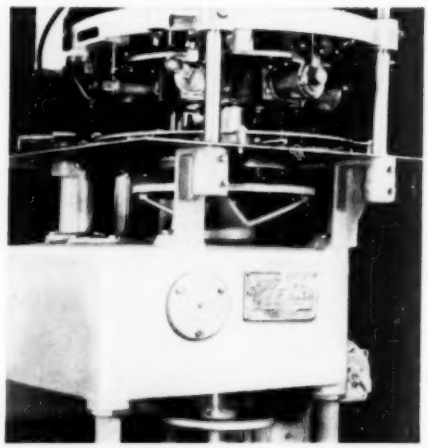

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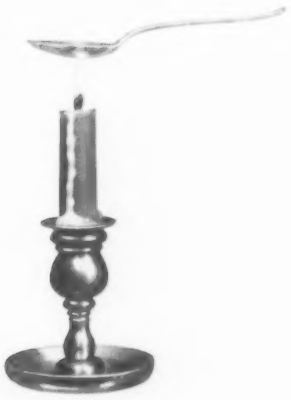

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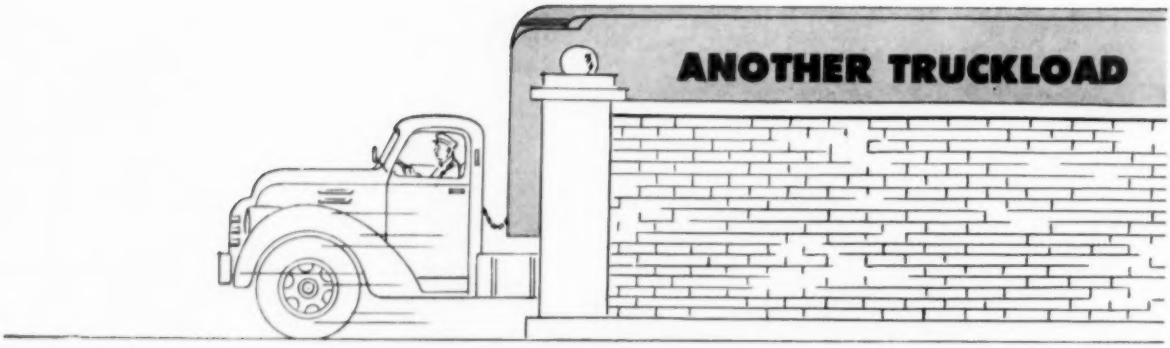

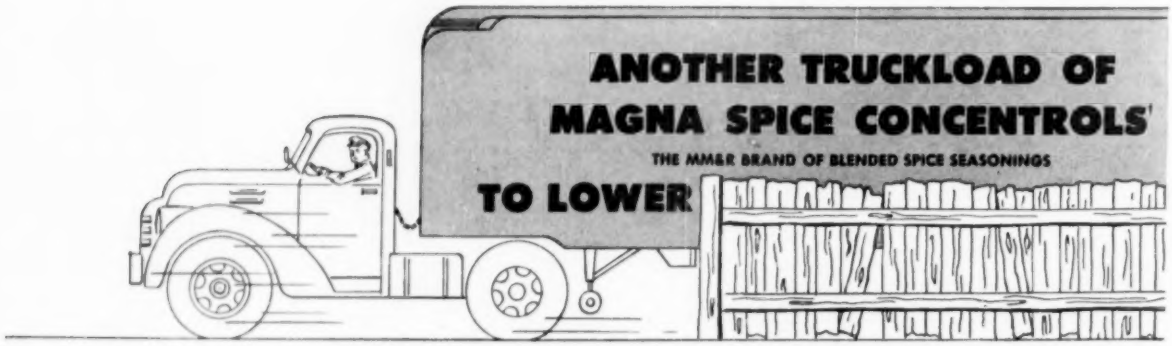

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FOOD TECHNOLOGY

Published Monthly by the Institute of Food Technologists

Volume 7 **November 1953** **Number 11**

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Address to this office all manuscripts, proofs, letters pertaining thereto, etc. Prospective contributors are invited to send for the pamphlet *Information and Suggestions to Authors* which contains style instructions.

Responsibility for statements appearing in FOOD TECHNOLOGY rests on the author thereof; points of view expressed in the columns of the journal do not necessarily have the indorsement of the Institute of Food Technologists.

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Address to the business office all requests for subscriptions, changes of address, and information on advertising. Claims for copies lost in the mails must be received 30 days after issue (90 days, foreign). Changes of address must be received at least two weeks before date of issue.

Subscription Rates: For members the cost of subscription is included in the annual dues. Non-members: domestic, $7.50 per year; foreign, $8.50 per year. Single and back copies: domestic, $1.00; foreign, $1.15.

Advertising Representatives: *Eastern:* Duncan Macpherson, 700 S. Washington Square, Philadelphia 6, Pa. *Midwestern:* Prendergast and Minahan, 168 N. Michigan Avenue, Chicago 1. *West Coast:* Duana Wanamaker, 610 S. Broadway, Los Angeles 14, California.

Publication Office

The Garrard Press, 119 West Park Avenue, Champaign, Illinois

Address to the Publication Office all requests for non-member subscriptions, back volumes, single copies (costs are listed above). Authors desiring reprints should address orders to this office; rates are printed on the order blank. (Requests for a single reprint of a published paper should be addressed to the author.)

FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by the Garrard Press, Champaign, Illinois, U. S. A.

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Mailing Permit: Entered as second-class matter, Feb. 25, 1947, at the Post Office at Champaign, Illinois, under the Act of August 24, 1912.

Contents

LOW TEMPERATURE, HIGH SPEED RENDERING—THE KINGAN PROCESS. W. R. Dayen, K. M. Christensen and R. E. Morse 421

INFLUENCE OF PIECE SIZE ON PRODUCTION AND QUALITY OF DEHYDRATED IRISH POTATOES. M. Simon, J. R. Wagner, V. G. Silveira, and C. E. Hendel 423

ANTIOXIDANT TREATMENT FOR BACON. J. W. Hanley, C. W. Everson, L. Q. Ashworth, and R. E. Morse 429

CRUMB SOFTNESS FROM SOY FRACTIONS. C. W. Ofelt, Allan K. Smith, and Paul A. Belter 432

THE VOLATILE CONTENT OF AIR IN COMMERCIAL APPLE STORAGES. S. W. Porritt, D. V. Fisher, and E. D. Edge 434

FAT INJECTION OF BEEF ANIMAL PARTS. K. G. Shea, I. S. Meyers, M. S. Rarick, and R. E. Morse 437

AIR PURIFICATION FOR APPLE STORAGES. D. V. Fisher, S. W. Porritt, and E. D. Edge 442

DEHYDRATED STABILIZED EGG. IMPORTANCE AND DETERMINATION OF pH. Harold Salwin, I. Bloch, and J. H. Mitchell, Jr. 447

THE INFLUENCE OF VINEGAR EELS (ANGUILLULA ACETI) ON VINEGAR PRODUCTION. Ralph C. Zalkan and F. W. Fabian 453

RELATIVE CHEMICAL, FUNCTIONAL, AND ORGANOLEPTIC STABILITIES OF ACIDIFIED AND GLUCOSE-FREE WHOLE EGG POWDERS. Leo Kline, T. F. Sonoda, and Helen L. Hanson and J. H. Mitchell, Jr. 456

PREPARATION OF STABLE FROZEN PUDDINGS. Helen L. Hanson, K. D. Nishita, and Hans Lineweaver 462

OBSERVATIONS ON THE CANNING OF PACIFIC COAST OR DUNGENESS CRABMEAT. Lionel Farber . . . 465

NOTES AND LETTERS

MODIFICATION OF THE PRE-ASHING APPARATUS FOR PREPARING SIRUPS AND OTHER HIGHLY FOAMING PRODUCTS 468

AFFAIRS OF THE INSTITUTE

FOOD FRONTIERS *1*

ROSTER OF 1953-54 COMMITTEES *8*

ANNUAL MEETING BULLETIN BOARD *22*

REGIONAL SECTION NEWS *24*

BOOKS *30*

SELECTED ABSTRACTS *34*

FUTURE DATES *39*

FOOD INDUSTRY TOPICS *40*

Affairs of the Institute

Food Frontiers	Books
Roster of 1953-54 Committees	Selected Abstracts
Annual Meeting Bulletin Board	Future Dates
Regional Section News	Food Industry Topics

The following address was delivered by Dr. Bernard E. Proctor, President, during 1952-53, of the Institute of Food Technologists, at the opening session of the Annual Meeting in Boston, on June 22, 1953. The content and spirit of Dr. Proctor's remarks remain timely, and the address eminently deserves a place in our permanent records.

Food Frontiers

This is indeed a pleasant occasion which permits me to serve as chairman and as a speaker in company with the other participants in our program this morning. I trust that we may appreciate the special significance of the presence of our guest from the British Isles, Dr. G. A. Reay, both because he is the representative of a greatly esteemed, important nation and because he is a member of a scientific group for which we in the food field have deep admiration.

To be accompanied on the program by the two chiefs and colleagues, Karl Taylor Compton and Samuel Cate Prescott, under whom I have served in various capacities and for whom I have the deepest respect, makes this a particularly happy session. Many members of our organization have been aware that our Institute of Food Technologists has been indebted for its very origin to these same two men, who furnished the "reaction chamber" and the "catalyst" for the first Food Technology Conferences, which were held in 1937 and 1939 at the Massachusetts Institute of Technology—conferences whose end product was the Institute of Food Technologists, a live and vital organization.

During the fourteen years that have elapsed since that time, much has happened. We have, as a nation, played a major part in one global war and a considerable part in what many of us consider the equivalent of a global war. In each of these emergencies, conspicuous professional service has been rendered to the United States and its allies by many of our members. At present much of the work relating to the rations of the armed services is the concern of our membership, in laboratories, packing plants, canneries, flour mills, bakeries, dairies, freezers and other food-manufacturing plants.

A live and vital organization. During this same period, our Institute of Food Technologists has grown from its inception to an organization approaching four thousand members, with members in many countries and regional sections in at least two countries outside the United States. Our Executive Secretary, Col. Charles S. Lawrence, at the annual meeting of our Council yesterday, presented statistics that show our membership is increasing rapidly and that our activities have made conspicuous progress during the past year.

Today the Institute of Food Technologists is a live and vital organization, taking an active interest and participating in the advancement of scientific knowledge and the developments pertinent to foods, their production, and their optimum use. Its stature has increased markedly over the years.

It is widely recognized that our members contribute not only to scientific knowledge in the food field but make constant practical application of such knowledge in the production of the many types of every-day foods that the world consumes, as well as food specialties of every description.

As our numbers have increased and the scope of our activities has widened over the past decade, The Institute of Food Technologists has become a dominant influence in the field of foods. It is a respected champion for improvement in food quality and more efficient food processes and equipment. Our organization is sought for its opinions in matters relating to food policies.

There is no group in this country in whose hands more responsibility is vested concerning the well-being of the American public from the standpoint of its food intake—because our membership represents the major element and, I am happy to say, the better element, not only in food production but also in the development of new foods, the improvement of older foods, and the welfare and protection of the public insofar as it relates to all aspects of food supply.

Certain other matters, about which most of our membership is informed, are deemed sufficiently important and timely to be mentioned briefly here. Man-power is always a matter of importance, both in war and in peace. It has been obvious for several years that the shortage of trained technical men is becoming more critical in the United States. This relates to food technologists as well as to other professional groups.

Despite the great demands for well-trained people in our food industries, the number of young men entering this type of training at the higher levels is not sufficient to meet the needs at present, and this situation may become critical in the future. Perhaps the best way to obviate this situation is for each of us to tell our young friends and relatives that there are futures in foods worthy of their attention and that there are incentives that may compensate their most serious efforts.

Chemicals in foods. Particularly pertinent to our interests at this time is the progress being made in respect to the matter of chemicals in foods. Our committee concerned with this important work, of which Dr. Charles N. Frey is chairman, has cooperated with the Food Protection Committee of the National Research Council. A number of important and informative statements by the latter group have been made in this respect recently, which will serve as guides to industry and government officials.

The protection of the ultimate food consumer is the first interest of all food technologists. It is the object of our organization to determine how this may best be accomplished and whether the proposed legislation may permit industry the necessary freedom of initiative and still provide adequate control by those authorities in whom such control is vested.

It has recently been proposed by a committee of the

National Research Council, of which Dr. Robert R. Williams is chairman, that scientific data relating to the determination of safety of new intentional additives in foods be considered by technical specialists in special session, rather than during food standard hearings. The majority of the members of this committee are members of our Institute.

It is believed that the new Congress will soon be considering various proposed bills suggested to improve the administrative jurisdiction over food components that are considered necessary additives. Sufficient information concerning the various proposals is not yet at hand to make a proper evaluation, but the very fact that new legislation is being considered has stimulated study along these lines by industry, government, the suppliers of such additives, educational institutions, and the layman. Out of all this will come a better mutual understanding, which should be beneficial to all concerned.

Cold sterilization. Much progress has been made in food technology in the past decade. The years just passed have given us more insight into the essential components of foods in relation to human health and how one may best preserve these important characteristics. This information will continue to be translated into new food processes yielding foods with increased plus factors in the form of better nutrition, flavor, color, and convenience, as well as safety. Much is known, but one may expect great progress in the future.

The following statement was made by Mr. Harlow H. Curtice, President of General Motors, early this year—and I quote:

> The importance of continuing progress based on science and technology is not well enough understood. It is the keystone of our modern society. It is the foundation upon which our prosperity and our increasing standard of living rest.
>
> Sometimes we are too close to events to see them in proper perspective. Personally I am confident that in this country we are in the midst of a tremendous upswing in technological progress, an upswing that will appear revolutionary, when we look back on it years hence.

Certainly this thought of Mr. Curtice is equally applicable in food technology.

On M. I. T.'s campus across the Charles, we have been investigating for some time in the Food Technology Laboratories the development of means that will permit the by-products of atomic fission to have a real place in the food industry. As in all research, special difficulties are to be overcome, but on this particular frontier the results look more encouraging as we progress.

Food research today—in common with other types of research—is rarely a one-man affair. The efforts of our group in this field have been made possible at M. I. T. by cooperation of investigators in other departments, notably Dr. Robert J. Van de Graaff of the Physics Department and Dr. John G. Trump of the Department of Electrical Engineering. These men were responsible for the design and the development of the high-voltage generators, which we in the Department of Food Technology have used in our research on the "cold sterilization" of foods, first by X-rays and more recently by cathode rays. Without such outstanding equipment available on our campus, our efforts would have been of little significance.

Because of the improved design of such equipment and because we have obtained increasing knowledge regarding the effects of ionizing radiations on color, flavor, and various components of foods, such as vitamins, amino acids, and enzymes, the potentials of this type of food sterilization have become more apparent. Much of this research has been published and will not be discussed here.

In the course of these investigations, however, have come many increments concerning the basic knowledge of the chemistry of food flavors, the determination and evaluation of food colors, new instrumentation applicable to heat penetration and dosimetry techniques which are capable of utilization in the field of radiation. A by-product of cooperative endeavors in this research has been the development by medical workers at the Children's Hospital of a method for the sterilization of human blood vessels, notably sections of aorta, which have been successfully transplanted. This suggests the intriguing possibility of human "tissue banks" for emergency purposes. It is thus evident again that unexpected dividends, that can never be prophesied in advance, may result from research.

Despite our interests and activities in research, the main product of our combined activities in the Samuel Cate Prescott Laboratories is men because our research program has as one of its major objectives the training of food technologists.

A new era. As a result of Hiroshima a new era has been ushered into the world—the atomic age. Previous to December 1942, man was able to utilize only one percent of the available energy of the universe. With the achievement of the first chain-reacting atomic pile, man has obtained a key to the utilization of the residual ninety-nine percent. Hiroshima and subsequent developments have thus opened new potential sources of energy for peace-time applications.

The fabrication of fissionable military weapons has resulted in the availability of presumably immense quantities of radioactive isotopes as by-products of atomic fission. These offer vast quanta of energy in the form of gamma radiation, available for other purposes.

We have been extending our knowledge regarding cold sterilization of foods without conventional heating by this type of energy, namely, gamma rays, comparing the bactericidal effects of such rays with the effects of X-rays and high-energy electrons. I must stress that all research of this type to date has been done with Cobalt-60, a source of gamma rays simulating by-products of atomic fission. It is expected that in the near future, with the use of actual fission by-products, we may be able to repeat the experiments made with Cobalt-60.

Intensive studies over the last fifteen months in the Food Technology Laboratories at the Massachusetts Institute of Technology have indicated that, from the standpoint of the food technologist, the bactericidal

(Continued on page 8)

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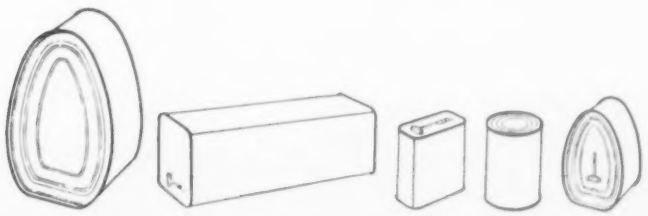

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FOOD FRONTIERS

(Continued from page 5)

effects of gamma rays from Cobalt-60, of X-rays, and of cathode rays are equivalent within limits that may be considered applicable to the inactivation of micro-organisms by ionizing radiations.

As a result of our recent studies, the vast amount of information concerning X-rays and electrons in respect to sterilization and insect inactivation now in the literature may be evaluated and calibrated in terms of a similar use for the by-products of atomic fission. Atomic energy may thus find one of its important peace-time applications in the food industry.

Each of the investigators represented in the 120 papers to be presented at our 1953 meeting of the Institute of Food Technologists is, in essence, providing a specific food frontier. Would it not be wonderful if we had the ability to know now which of these reports may be the ones that will provide the future trends that we or our successors will be following in the years ahead? Certainly some will be in that category.

Sufficient for the moment, perhaps is the thought that without food technologists, without a forum such as is provided by our Institute of Food Technologists, without a community of interests, without literature, and without mental stimulation—without the possibility of friends meeting friends with common interests—there would be no progress in the field of food technology, a field that we deeply believe is of outstanding importance not only to ourselves and our country but to the world and its future.

So I say—let us appreciate our individual food frontiers, let us return home stimulated and dedicated to the tasks ahead, with continued enthusiasm and advanced technical know-how for the making of better foods directed toward the improvement of all mankind in what we hope may be eventually a peaceful world.

Roster of 1953-54 Committees

Institute of Food Technologists

Committee appointments for the year 1953-54 have been announced by Dr. B. S. Clark, President of the Institute of Food Technologists. The committees, their respective objectives, and the membership of each follow:

EXECUTIVE COMMITTEE OF THE COUNCIL

The responsibility of this Committee is to exercise for and on behalf of the Council, all of the functions the Council may authorize by resolution. See Article VII, Section 7, of the Constitution and Article IX, Section 1 of the By-Laws.

B. S. Clark, *Chairman*
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Massachusetts Institute of Technology
Cambridge, Mass.

A. C. Richardson
California Packing Corp.
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San Francisco 19, Calif.

COMMITTEE ON CONSTITUTION

This Committee is responsible for evaluating all proposals for changes in the Constitution or By-Laws, and recommending to the Executive Committee and the Council such action as committee investigation indicates to be desirable. The Committee Chairman should work closely with the President and the Executive Secretary on all matters involving any change in procedures.

This Committee also collaborates and advises with other committees on problems which may call for changes in either the Constitution or the By-Laws, and makes appropriate recommendations for action to the Council. This, however, does not prevent any other committee from making its own proposals directly to the Council, in which case it usually becomes this Committee's function to prepare for final approval whatever change in operating rules Council action may indicate.

Lloyd A. Hall, *Chairman*
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Chicago 9, Ill.

Frank L. Gunderson
1003 duPont Circle Bldg.
Washington 6, D. C.

Arnold H. Johnson
National Dairy Research Laboratories
Oakdale, L. I., N. Y.

COMMITTEE ON EXHIBITS

The responsibility of this Committee is to assist the Exhibits Chairman in the work of soliciting exhibits for the 1954 convention at Los Angeles and undertake such other duties as the Chairman may indicate as important to assure a successful exhibit program at the Los Angeles meeting.

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C. S. Lawrence
Institute of Food Technologists
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Chicago 3, Ill.

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(Continued on page 11)

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ROSTER OF 1953-54 COMMITTEES

(Continued from page 8)

W. J. SCARLETT
Minneapolis-Honeywell Reg. Co.
Brown Inst. Div.
Wayne & Windrim Aves.
Philadelphia 44, Pa.

A. A. SCHAAL
Good Housekeeping Bureau
57th St. at 8th Ave.
New York 19, N. Y.

N. H. VOLLE
The Kroger Co.
1212 State Ave.
Cincinnati 4, Ohio

R. V. WILSON
Continental Can Company
4645 W. Grand Ave.
Chicago 39, Ill.

FINANCE COMMITTEE

This Committee has the responsibility of initiating policy in respect to the handling of Institute finances, of approving the annual budget, and of discharging such other duties in connection with the business affairs of the Institute as may be assigned to it by the Treasurer.

AKSEL G. OLSEN, *Chairman*
General Foods Corporation
Central Laboratories
Hoboken, N. J.

BYRON M. SHINN
Armour & Company
Union Stock Yards
Chicago 9, Ill.

RAY B. WAKEFIELD
Gerber Products Company
Fremont, Mich.

ALBIN H. WARTH
Crown Cork & Seal Company
P. O. Box 1837
Baltimore 3, Md.

COMMITTEE ON MEMBERSHIP

Objective: To initiate, guide, and encourage local and national activities for increasing the national membership.

L. E. CLIFCORN, *Chairman*
Continental Can Co., Inc.
4645 W. Grand Ave.
Chicago 39, Ill.

S. A. GOLDBLITH
Dept. Food Technology
Massachusetts Institute of Technology
Cambridge, Mass.

R. N. LAY
American Can Co.
So. Lockwood and Clinton Drive
Houston 1, Tex.

P. E. RAMSTAD
Oscar Mayer & Co.
Madison 1, Wis.

R. G. TISCHER
Quartermaster Food and Container Institute
1849 W. Pershing Rd.
Chicago, Ill.

HELEN L. HANSON
Western Regional Research Laboratories
800 Buchanan St.
Albany 6, Calif.

J. G. WOODROOF
Georgia Experiment Station
Experiment, Ga.

COMMITTEE ON NOMINATIONS

The nominees for officers and councilors-at-large shall be selected by the Committee on Nominations as described in Article VIII, Section 1, of the Constitution.

Members-at-Large:

IMRI J. HUTCHINGS, *Chairman*
H. J. Heinz Company
P. O. Box 57
Pittsburgh 30, Pa.

JOHN C. AYRES
Iowa State College
Ames, Iowa.

THOMAS B. CALDER
W. Clark, Ltd.
Montreal, P. Q., Can.

EDWIN L. MITCHELL
Richmond-Chase Company
San Jose 8, Calif.

ROGER PATRICK
Citrus Experiment Station
Lake Alfred, Fla.

Regional Members:

Chairmen of all Regional Sections

PROGRAM COMMITTEE

This Committee is responsible for preparing the program for the 1954 Annual Meeting.

A. N. PRATER, *Chairman*
Gentry Division
Consolidated Grocers Corp.
Box 2076 Terminal Annex
Los Angeles 54, Calif.

M. L. ANSON
Lever Brothers Company
45 River Road
Edgewater, N. J.

F. E. ATKINSON
Dominion Experimental Station
Summerland, B. C., Can.

E. A. BEAVANS
U. S. Department of Agriculture
263 S. Chester Ave.
Pasadena 5, Calif.

K. W. BRIGHTON
Research Division
American Can Company
11th Ave. & St. Charles Road
Maywood, Ill.

S. M. CANTOR
American Sugar Refining Company
Foot of Tasker Street
Philadelphia 48, Pa.

L. E. CLIFCORN
Continental Can Company
4645 W. Grand Ave.
Chicago, Ill.

G. A. CRAPPLE
Wilson & Company
4100 S. Ashland Ave.
Chicago 9, Ill.

J. R. ESTY
National Canners Association
1950 Sixth St.
Berkeley 2, Calif.

E. GEIGER
3842 Monteith Drive
Los Angeles 43, Calif.

D. B. HAND
Division of Food Science & Technology
Agricultural Experiment Station
Geneva, N. Y.

MARJORIE HEID
1159 W. Valley View Drive
Fullerton, Calif.

I. J. HUTCHINGS
H. J. Heinz Company
Pittsburgh 30, Pa.

W. R. JOHNSTON
Standard Brands, Inc.
810 Grand Concourse
New York 51, N. Y.

H. R. KRAYBILL
American Meat Institute Foundation
939 E. 57th St.
Chicago 37, Ill.

E. E. LOCKHART
Department of Food Technology
Massachusetts Institute of Technology
Cambridge, Mass.

A. C. RICHARDSON
California Packing Corp.
215 Fremont St.
San Francisco 19, Calif.

W. R. ROY
Minute Maid Corp.
Plymouth, Fla.

R. G. TISCHER
Quartermaster Food & Container Inst.
1819 W. Pershing Road
Chicago 9, Ill.

D. K. TRESSLER
Quartermaster Food & Container Inst.
1819 W. Pershing Road
Chicago 9, Ill.

W. B. VAN ARSDEL
Western Regional Research Laboratory
Albany, Calif.

R. H. VAUGHN
Department of Food Technology
University of California
Davis, Calif.

R. H. WALTERS
General Foods Corporation
250 Park Ave.
New York 17, N. Y.

COMMITTEE ON PUBLICATIONS

By resolution of the Council, this Committee serves in an advisory capacity to the Council on overall policy, and is free to examine and make recommendations on any matters concerning the publication enterprise, including the financial support of the journals, selection of the editors, and coordination of all publication activities.

R. B. WAKEFIELD, *Chairman*
Gerber Products Company
Fremont, Mich.

P. K. BATES
Carnation Research Laboratories
8015 Van Nuys Blvd.
Van Nuys, Calif.

(Continued on page 12)

ROSTER OF 1953-54 COMMITTEES

(Continued from page 11)

K. W. Brighton
American Can Company
Research Division
Maywood, Ill.

G. A. Crapple
Wilson & Company, Inc.
4100 S. Ashland Ave.
Chicago 9, Ill.

W. R. Johnston
Standard Brands
Fleischman Laboratory
810 Grand Concourse
New York 51, N. Y.

NATIONAL PUBLICITY COMMITTEE

The prime objective of this Committee is to enlarge the news program and improve its design to enhance the prestige and stature of the Institute, and to advance the status of food technology as a profession.

The Committee has both functional and advisory responsibilities. It should assist the editor in procuring more news items of national importance for release through channels established by the Executive Secretary and advise the Executive Secretary on ways and means of amplifying this coverage.

While responsibility for Annual Meeting publicity will be the function of the Host Section Publicity Committee, the National Committee will supplement the program of the Host Section Committee by release of news items, through established channels, calculated to develop interest in the Annual Meeting program.

The National Committee will advise the Executive Committee on matters of new policy and recommend procedures designed to improve the news release program of the Institute.

R. H. Walters, *Chairman*
General Foods Corporation
250 Park Ave.
New York 17, N. Y.

P. K. Bates
Carnation Research Labs.
8015 Van Nuys Blvd.
Van Nuys, Calif.

H. T. Griswold
Owens-Illinois Glass Co.
P. O. Box 3431 Rincon Annex
San Francisco 19, Calif.

C. G. King
The Nutrition Foundation, Inc.
405 Lexington Ave.
New York 17, N. Y.

P. DeC. Kratz
Hoffman Beverage Co.
400 Grove St.
Newark 6, N. J.

F. K. Lawler
Food Industries
McGraw-Hill Publishing Co.
300 W. 42nd St.
New York 18, N. Y.

R. H. Lueck
American Can Co.
100 Park Ave.
New York 17, N. Y.

Regional Members:

Publicity Chairmen of all Regional Sections

COMMITTEE ON QUALIFICATIONS

This Committee shall examine the applications of candidates for membership and accept or reject such applications. The Committee shall also determine the class of membership for which an applicant is accepted. The determinations of the Committee shall be subject to review by the Council at any time See Article XI, Section 2, of the Constitution.

Roy E. Morse, *Chairman*
Wm. J. Stange Company
342 N. Western Ave.
Chicago, Ill.

William F. Massmann, Jr.
General Foods Corporation
Post Cereals Division
275 Cliff St.
Battle Creek, Mich.

Milton E. Parker
Illinois Institute of Technology
3300 S. Federal St.
Chicago, Ill.

COMMITTEE ON REGIONAL SECTIONS

Objectives: To study new applications for Regional Sections, to advise the Executive Committee and the Council regarding Section boundaries and other inter-section problems, and to promote inter-sectional exchange of ideas for advancing the interests of the Institute.

J. C. Moyer, *Chairman*
Division of Food Science & Technology
New York State Agricultural Experiment Station
Geneva, N. Y.

F. E. Atkinson
Experimental Farm Service
Canada Dept. of Agriculture
Summerland, B. C., Can.

R. T. Bohn
35 Valley Road
Scarsdale, N. Y.

M. S. Burns
California Vegetable Concentrates, Inc.
2460 East Glenoaks
Glendale 6, Calif.

W. S. Conway, Jr.
Richardson Corporation
1069 Lyell Ave.
Rochester 3, N. Y.

W. H. Cook
Division of Applied Biology
National Research Council
Ottawa 2, Ontario, Can.

G. A. Crapple
Research & Technical Division
Wilson & Company
4100 S. Ashland Ave.
Chicago 9, Ill.

F. J. Erickson
2220 Lakeview
St. Joseph, Mich.

C. R. Fellers
Dept. of Food Technology
University of Massachusetts
Amherst, Mass.

G. E. Felton
Hawaiian Pineapple Co., Ltd.
P. O. Box 3380
Honolulu 1, Hawaii

R. G. Foster
Campbell Soup Co.
Camden 1, N. J.

C. E. Gross
John Morrell & Co.
Ottumwa, Iowa

C. D. Lamberton
American Can Co.
Clinton & Lockwood Dr.
Houston 1, Tex.

E. M. Litwiller
Food Technology Dept.
Oregon State College
Corvallis, Ore.

R. D. McKirahan
American Can Co.
20th & 3rd Sts.
San Francisco, Calif.

F. C. Olson
Oscar Mayer & Co.
207 N. Allen St.
Madison 5, Wis.

L. B. Sjostrom
Arthur D. Little, Inc.
30 Memorial Drive
Cambridge 42, Mass.

COMMITTEE ON RESOLUTIONS

Objective: To prepare appropriate resolutions and present them at the annual business meeting as authorized by the Executive Committee and the Council.

E. A. Beavens, *Chairman*
California Fruit & Vegetable Chemical Laboratory
U. S. Dept. of Agriculture
263 S. Chester Ave.
Pasadena 5, Calif.

R. T. Bohn
35 Valley Road
Scarsdale, N. Y.

M. T. Rogers
Dewey & Almy Chemical Co.
Cambridge, Mass.

C. C. Strachan
Department of Agriculture
Experimental Station
Summerland, B. C., Can.

COMMITTEE ON STUDENT MEMBERSHIP

Objectives:

(a) To guide and promote the establishment of student chapters at educational institutions and encourage cooperation of Regional Sections with the student activities.

(b) To study all matters pertaining to student membership and make such recommendations to the Executive Committee of the Council as Committee investigation indicates to be of advantage to the student members and in the interests of the Institute.

O. J. Worthington, *Chairman*
Food Technology Department
Oregon State College
Corvallis, Ore.

J. C. Ayres
1412 Harding Ave.
Ames, Iowa

F. W. Fabian
Department of Bacteriology
Michigan State College
East Lansing, Mich.

Ira D. Garard
New Jersey College for Women
New Brunswick, N. J.

(Continued on page 14)

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ROSTER OF 1953-54 COMMITTEES

(Continued from page 12)

S. A. Goldblith
Department of Food Technology
Massachusetts Institute of Technology
Cambridge, Mass.

M. Kaplow
Box 698
Amherst, Mass.

A. S. Levine
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University of Massachusetts
Amherst, Mass.

W. A. MacLinn
Department of Food Technology
Rutgers University
New Brunswick, N. J.

A. I. Nelson
Food Technology Department
University of Illinois
Urbana, Ill.

H. A. Schuette
Department of Chemistry
University of Wisconsin
Madison, Wis.

C. Sterling
Department of Food Technology
University of California
Davis, Calif.

R. G. Tischer
Quartermaster Food & Container Institute
1849 W Pershing Rd.
Chicago 9, Ill.

COMMITTEE TO REPRESENT IFT AT AMERICAN ASSOCIATION FOR ADVANCEMENT OF SCIENCE

Objective: To serve as representatives of the Institute of Food Technologists on the coordinating committee of the American Association for the Advancement of Science and report to the Council transactions of interest to the Institute.

C. N. Frey
45 Cambridge Road
Scarsdale, N. Y.

P. F. Sharp
University of California
Berkeley, Calif.

COMMITTEE FOR LIAISON WITH ARMED FORCES

Objective: To make available to the food procurement agencies of the Armed Forces the expert knowledge and experience of the Institute of Food Technologists and present the viewpoints and interests of the Institute in all matters relating to the food procurement problems of the Armed Forces.

A. N. Prater, *Chairman*
Gentry Division
Consolidated Grocers Corporation
Box 2076 Terminal Annex
Los Angeles 54, Calif.

G. M. Dack
Food Research Institute
University of Chicago
Chicago 37, Ill.

H. C. Diehl
Refrigeration Research Foundation
200 Midland Bldg.
Colorado Springs, Colo.

A. L. Elder
Corn Products Refining Co.
Argo, Ill.

C. N. Frey
45 Cambridge Road
Scarsdale, N. Y.

J. F. Hale
The Borden Company
600 N. Franklin St.
Syracuse, N. Y.

C. G. Harrel
Pillsbury Mills Inc.
Research & Development Lab.
208 Third Ave., S. E.
Minneapolis 14, Minn.

R. A. Isker
Associates, Food & Container Institute, Inc.
1849 W. Pershing Road
Chicago 9, Ill.

H. K. Murer
General Foods Corp.
Central Laboratories
1125 Hudson St.
Hoboken, N. J.

D. K. Tressler
Quartermaster Food & Container Institute
1819 W. Pershing Rd.
Chicago 9, Ill.

COMMITTEE FOR COOPERATION WITH CANADIAN FOOD TECHNOLOGISTS

Objective: To study the problem of developing international relations which will promote the best interests of food technology in both Canada and the United States.

P. K. Bates, *Chairman*
Carnation Research Laboratories
8015 Van Nuys Blvd.
Van Nuys, Calif.

K. G. Dykstra
Birds Eye Laboratories
General Foods Corp.
Albion, N. Y.

R. E. Marshall
Agricultural Experiment Station
Michigan State College
Lansing, Mich.

W. D. Pheteplace
The Pfaudler Co.
Food & General Machinery Division
Rochester, N. Y.

COMMITTEE ON CHEMICALS IN FOODS

Objectives:

(a) To formulate a plan to collect available information (technological, pharmacological, and medical) regarding new developments in the field of chemicals in foods.

(b) To arrange for contacts with committees of other organizations, including industry, concerned with chemicals in foods, in order to aid in the collection of information.

(c) To build up a group of informed people who will meet as often as possible for exchange of ideas originating through channels of the IFT Committee on Chemicals in Foods.

(d) To disseminate information so obtained to:
(1) IFT membership and others, including legislators.
(2) Food processors.
(3) Regulatory officials.
(4) General public, on request.

(e) To represent IFT in all matters pertaining to chemicals and chemical residues in foods.

(f) To act in any way requested as an advisory group to the Food Protection Committee of the National Research Council.

(g) To serve as a liaison organization to convey information from the NRC Food Protection Committee to IFT members and to express the sentiments of the IFT Council to the NRC Food Protection Committee.

(h) To publish, periodically, reports concerning progress in this field in one of the IFT publications, either Food Technology or Food Research.

C. N. Frey, *Chairman*
45 Cambridge Road
Scarsdale, N. Y.

F. C. Blanck
203 Hoodridge Ave.
Pittsburgh 34, Pa.

E. J. Cameron
National Canners Association
1133 20th St., N. W.
Washington 6, D. C.

M. J. Copley
U. S. Department of Agriculture
800 Buchanan St.
Albany 6, Calif.

A. L. Elder
Corn Products Refining Co.
Argo, Ill.

C. A. Elvehjem
University of Wisconsin
Biochemistry Department
Madison, Wis.

G. F. Garnatz
Kroger Food Foundation
1212 State Ave.
Cincinnati 4, Ohio

W. F. Geddes
University of Minnesota
University Farm
St. Paul 1, Minn.

C. A. Glabau
American Trade Publishing Co.
45 W. 45th St.
New York 36, N. Y.

F. L. Gunderson
1003 DuPont Circle Bldg.
Washington 6, D. C.

D. B. Hand
Div. of Food Science & Technology
Agricultural Experiment Station
Geneva, N. Y.

R. K. Hower
National Biscuit Co.
449 W. 14th St.
New York 11, N. Y.

W. R. Johnston
Standard Brands, Inc.
The Fleischman Laboratories
810 Grand Concourse
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$$\text{glucose} + \text{oxygen} \longrightarrow \text{gluconic acid}$$

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Firm Name_____

Address _____

City_____ Zone_____ State_____

ROSTER OF 1953-54 COMMITTEES

(Continued from page 14)

J. R. MATCHETT
Bureau of Agricultural and Industrial Chemistry
U. S. Department of Agriculture
Washington, D. C.

E. M. MRAK
Food Technology Division
University of California
Davis, Calif.

H. K. MURER
General Foods Corp. Central Laboratory
1125 Hudson St.
Hoboken, N. J.

B. L. OSER
Food Research Laboratories
48-14 Thirty-Third St.
Long Island City 1, N. Y.

F. N. PETERS
Quaker Oats Company
Research Laboratories
345 E. 25th St.
Chicago 16, Ill.

H. E. ROBINSON
Swift & Company Research Laboratory
Union Stock Yards
Chicago 9, Ill.

H. C. SPENCER
Dow Chemical Company
Midland, Mich.

C. P. WHITLOCK
Merck & Company, Inc.
Rahway, N. J.

COMMITTEE ON CITRUS PRODUCTS

Objective: To review and study industry-wide specific problems of the Committee's own selection. These problems are selected on the premise that their solution can best be effected by industry-wide committee action, and that such solution will simultaneously benefit the citrus products industry, food technology in general, and the Institute.

F. W. WENZEL, JR., *Chairman*
Citrus Experiment Station
University of Florida
Lake Alfred, Fla.

W. E. BAIER
Sunkist Growers, Inc.
Research Department
616 East Grove St.
Ontario, Calif.

E. A. BEAVENS
U. S. Department of Agriculture
263 So. Chester Ave.
Pasadena 5, Calif.

E. J. CAMERON
National Canners Laboratories
1133 20th St., N. W.
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H. CAMPBELL
830 West 4th St.
Ontario, Calif.

K. G. DYKSTRA
General Foods Corp.
162 S. Main St.
Albion, N. Y.

F. P. GRIFFITHS
U. S. Fruit & Vegetable Products Laboratory
Weslaco, Tex.

J. L. HEID
Golden Citrus Juices, Inc.
Fullerton, Calif.

L. G. MACDOWELL
Florida Citrus Commission
Lakeland, Fla.

V. C. PRASCHAN
Clinton Foods, Inc.
Florida Division
Auburndale, Fla.

R. H. VAUGHN
Division of Food Technology
University of California
Davis, Calif.

M. K. VELDHUIS
U. S. Citrus Products Station
Winter Haven, Fla.

COMMITTEE ON EDUCATION FOR FOOD TECHNOLOGISTS

Objective: To review the education and curricula offered for the training of food technologists by various colleges and universities in this country, and to study the education and special training demands of employers of food technologists, as a basis for making recommendations through the proper channels in the Institute of Food Technologists for education and curricula which will be most constructive to the profession.

W. A. MACLINN, *Chairman*
Department of Food Technology
Rutgers University
New Brunswick, N. J.

H. D. BROWN
Horticultural Department
Ohio State University
Columbus, Ohio

B. A. EAGLES
Faculty of Agriculture
University of British Columbia
Vancouver 8, B. C., Can.

C. R. FELLERS
Food Technology Department
University of Massachusetts
Amherst, Mass.

M. E. HIGHLANDS
Agricultural Experiment Station
Orono, Me.

R. E. MARSHALL
Michigan State College
East Lansing, Mich.

H. S. OLCOTT
Western Regional Research Laboratory
800 Buchanan St.
Albany 6, Calif.

L. B. ROCKLAND
U. S. Dept. of Agriculture
263 S. Chester Ave.
Pasadena 5, Calif.

E. ROSS
Horticulture Department
Washington State College
Pullman, Wash.

E. H. WIEGAND
Food Technology Department
Oregon State College
Corvallis, Ore.

COMMITTEE ON FOOD STANDARDS (AD HOC)

Objective: To evaluate the responsibility of the Institute with respect to the procedure for development of standards of identity for food products.

F. C. BLANCK, *Chairman*
203 Hoodridge Drive
Pittsburgh 34, Pa.

W. E. BAIER
Sunkist Growers, Inc.
Research Department
616 East Grove St.
Ontario, Calif.

G. A. CRAPPLE
Wilson & Co.
4100 So. Ashland Ave.
Chicago 9, Ill.

W. F. GEDDES
University of Minnesota
University Farm
St. Paul, Minn.

L. A. HALL
The Griffith Laboratories, Inc.
1415 West 37th St.
Chicago 9, Ill.

J. E. MCCONKIE
California Packing Corp.
101 California St.
San Francisco, Calif.

A. G. OLSEN
General Foods Corp.
1125 Hudson St.
Hoboken, N. J.

F. N. PETERS
The Quaker Oats Co.
345 East 25th St.
Chicago 16, Ill.

H. W. VAHLTEICH
The Best Foods, Inc.
Bayonne, N. J.

COMMITTEE ON FROZEN FOODS

Objectives:

(a) To study the development and progress of this comparatively new branch of food technology and to review the present status of the frozen foods industry—its technological and economical aspects.

(b) To coordinate the frozen foods industry with the educational institutions and other research agencies in improving the techniques and processes of freezing preservation of foods, and to indicate the need and direction for further research, both fundamental and applied.

(c) To suggest the need for the development of new products, and to assist the various interested agencies to accomplish this purpose.

(d) To compile data for establishing frozen foods standards through cooperation with representatives of the government and industry.

(e) To conduct the frozen foods session at the annual IFT meetings and to stimulate and encourage research on the freezing preservation of foods.

K. G. DYKSTRA, *Chairman*
Birds Eye Laboratories
General Foods Corp.
162 South Main Street
Albion, New York

W. E. BAIER
Sunkist Growers, Inc.
Research Department
616 East Grove St.
Ontario, Calif.

(Continued on page 18)

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ROSTER OF 1953-54 COMMITTEES

(Continued from page 16)

C. W. DuBois
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Plymouth, Fla.

C. F. Evers
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International Minerals & Chemical Corporation
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R. M. Hagen
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W. J. Hart, Jr.
John H. Dulany & Son, Inc.
Fruitland, Md.

A. Kramer
Department of Horticulture
University of Maryland
College Park, Md.

F. A. Lee
Division of Chemistry
New York State Agricultural Experiment Station
Geneva, N. Y.

E. L. Morin
Seabrook Farms Company
Bridgeton, N. J.

A. I. Nelson
Food Technology Department
University of Illinois
Urbana, Illinois

J. T. R. Nickerson
Department of Food Technology
Massachusetts Institute of Technology
Cambridge, Mass.

R. W. Olsen
Citrus Experiment Station
University of Florida
Lake Alfred, Fla.

F. R. Saunders
Snowflake Canning Co.
Corinna, Me.

H. P. Schmitt
National Association of Frozen Food Packers
1415 K Street, N. W.
Washington, D. C.

D. E. Sorber
U. S. Department of Agriculture
Western Regional Research Laboratory
Albany, Calif.

A. L. Tappel
Division of Food Technology
University of California
Davis, Calif.

Gladys E. Vail
Department of Foods and Nutrition
Purdue University
Lafayette, Ind.

G. J. Woodroof
Georgia Agricultural Experiment Station
Experiment, Ga.

O. J. Worthington
Food Technology Department
Oregon State College
Corvallis, Ore.

REPRESENTATIVE OF THE IFT ON THE FOOD AND NUTRITION BOARD OF THE NATIONAL RESEARCH COUNCIL

All appointments to the Food and Nutrition Board are made by the Chairman of the National Research Council. At the invitation of the National Research Council, the President of the IFT nominates a member for consideration and appointment as Liaison Representative. This appointment is for an indefinite period, but like all committee appointments is subject to annual reaffirmation by the President of the Institute. An annual report is made to the Council.

F. C. Blanck
203 Hoodridge Drive
Pittsburgh 34, Pa.

COMMITTEE ON PECTIN STANDARDIZATION

Objective: To establish a standard method for grading pectin.

E. E. Meschter, *Chairman*
The American Preserve Company
Lehigh Ave. and Third St.
Philadelphia, Pa.

E. R. Barron
First National Stores, Inc.
5 Middlesex Ave.
Somerville 45, Mass.

J. J. R. Bristow
Juice Industries Division
Clinton Foods, Inc.
P. O. Box 157
Dunedin, Fla.

R. E. Buck
H. J. Heinz Company
P. O. Box 57
Pittsburgh 30, Pa.

H. A. Campbell
General Foods Corporation
Central Laboratory
1125 Hudson St.
Hoboken, N. J.

G. H. Joseph
Sunkist Growers, Inc.
Research Department
P. O. Box 215
Corona, Calif.

Z. I. Kertesz
New York State Agricultural Experiment Station
Division of Food Science and Technology
Geneva, N. Y.

H. T. Leo
Mutual Citrus Products Co.
Anaheim, Calif.

H. H. Mottern
Kraft Foods Company
923 Waukegan Rd.
Glenview, Ill.

J. D. Nelson
John C. Morgan Company
Traverse City, Mich.

Mamie Olliver
Messrs. Chivers & Sons Ltd. Histon
Cambridge, England

H. S. Owens
U. S. Department of Agriculture
800 Buchanan St.
Albany 6, Calif.

W. A. Rooker
H. F. Byrd Company
Winchester, Va.

W. Scardino
Speas Company
Kansas City 20, Mo.

H. H. Shockey
National Fruit Products Co., Inc.
P. O. Box 609
Winchester, Va.

W. L. Walde
National Preservers Association
Room 626
1346 Connecticut Ave., N. W.
Washington 6, D. C.

R. E. Webb
Bedford Products Co.
Dunkirk, N. Y.

J. J. Willaman
Bureau of Agricultural & Industrial Chemistry
Eastern Regional Research Laboratory
Philadelphia 18, Pa.

C. W. Woodmansee
Agricultural Experiment Station
University of Delaware
Newark, Del.

COMMITTEE ON OBJECTIVE QUALITY CONTROL MEASURING METHODS

Objective: To study and evaluate measuring methods for use in controlling the quality of food products. It is responsible for selecting the quality factors to be included in these studies.

G. Mackinney, *Chairman*
University of California
Department of Food Technology
Berkeley 4, Calif.

B. W. Clarke
The Crosse & Blackwell Co.
6801 Eastern Ave.
Baltimore 24, Md.

H. E. Goresline
Quartermaster Food & Container Institute
1819 W. Pershing Rd.
Chicago 9, Ill.

D. B. Hand
New York State Agricultural Experiment Station
Lock Drawer 353
Geneva, N. Y.

M. E. Highlands
Agricultural Experiment Station
University of Maine
Holmes Hall
Orono, Me.

A. Kramer
Department of Horticulture
University of Maryland
College Park, Md.

D. W. Leeper
H. J. Heinz Co.
Quality Control Laboratory
Pittsburgh 30, Pa.

H. R. MacDonnell
The Great A. & P. Tea Co.
Research Department
New York, N. Y.

W. A. MacLinn
Food Technology Department
Rutgers University
New Brunswick, N. J.

B. Makower
Western Regional Research Laboratory
Albany, Calif.

A. I. Nelson
Food Technology Department
University of Illinois
Urbana, Ill.

(Continued on page 21)

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ROSTER OF 1953-54 COMMITTEES

(Continued from page 18)

J. T. R. Nickerson
Department of Food Technology
Massachusetts Institute of Technology
Cambridge 39, Mass.

C. D. Trombold
Campbell Soup Co.
Camden, N. J.

O. J. Worthington
Food Technology Department
Oregon State College
Corvallis, Ore.

COMMITTEE ON TASTE TESTING AND CONSUMER PREFERENCE

Objectives:

(a) To bring order out of chaos in this field where empiricism is rampant, definitions and terminology need to be established, methodology needs to be screened, evaluated, and developed, and the results of such tests need to be interpreted in significant terms.

(b) To keep work in this field before business organizations and the public in order to impart to it status and prestige.

(c) To encourage research effort in this field and to point out those sub-areas which are most urgently in need of research.

G. F. Garnatz, *Chairman*
Kroger Food Foundation
1212 State Ave.
Cincinnati 4, Ohio

Esther L. Batchelder
8 Devon Road
Silver Spring, Md.

D. Foster
U. S. Testing Co.
1415 Park Ave.
Hoboken, N. J.

Helen L. Hanson
Western Regional Research Laboratory
Albany 6, Calif.

J. C. Hening
New York State Agricultural Experiment Station
Lock Drawer 353
Geneva, N. Y.

Elly Hinreiner
Division of Food Technology
University of California
Davis, Calif.

N. H. Ishler
General Foods Central Laboratories
1125 Hudson St.
Hoboken, N. J.

A. Kramer
Department of Horticulture
University of Maryland
College Park, Md.

E. E. Lockhart
Department of Food Technology
Massachusetts Institute of Technology
Cambridge, Mass.

Catherine J. Personius
College of Home Economics
Cornell University
Ithaca, N. Y.

D. R. Peryam
Quartermaster Food & Container Institute
1849 W. Pershing Road
Chicago 9, Ill.

L. B. Sjostrom
Arthur D. Little, Inc.
30 Memorial Drive
Cambridge 42, Mass.

COMMITTEE FOR THE EVALUATION OF METHODS AND TECHNIQUES USED IN THERMAL RESISTANCE STUDIES

Objectives:

(a) To assemble the details of procedure currently used in various methods of thermal resistance testing and compile the significant technique differences.

(b) Study these details of procedure to determine the technique factors which require inter-laboratory check testing.

(c) Arrange for preparation of spore suspensions by the various methods reported under Item a, and distribute these suspensions to participating laboratories for testing.

(d) Interpret and evaluate the test data and formulate a standardized procedure.

I. J. Hutchings, *Chairman*
H. J. Heinz Company
P. O. Box 57
Pittsburgh 30, Pa.

F. W. Barber
National Dairy Research Laboratory, Inc.
Oakdale, L. I., N. Y.

W. B. Esselen
Department of Food Technology
University of Massachusetts
Amherst, Mass.

G. L. Hays
American Can Company
Research & Technical Department
Maywood, Ill.

L. B. Jensen
Swift & Co.
Union Stock Yards
Chicago 9, Ill.

T. Mansfield
Food Machinery & Chemical Corp.
P. O. Box 367
San Jose 3, Calif

W. S. Ogilvy
Armour & Company
Research Division
Chicago 9, Ill.

J. M. Reed
National Canners Association
1133 20th St., N. W.
Washington 6, D. C.

H. Reynolds
Bureau of Human Nutrition and Home Economics
Beltsville Research Center
Beltsville, Md.

C. F. Schmidt
Continental Can Company
4645 W. Grand Ave.
Chicago 39, Ill.

C. R. Stumbo
H. J. Heinz Company
Pittsburgh 30, Pa.

C. T. Townsend
National Canners Association
Berkeley, Calif.

O. B. Williams
University of Texas
Austin, Tex.

AWARDS COMMITTEE

Objectives:

(a) To consider procedures relating to the mechanics of the selection of recipients of awards.

(b) To suggest procedures for improvements in the methods of presentation of awards for the National IFT and the publicity to be given these awards.

(c) To recommend future policies concerning the agencies granting awards and the integration of the award with the activities of IFT.

(d) To study policies relating to any future proffers of gifts, donations, or endowments and to recommend procedures regarding acceptance.

(e) To consider the establishment of an annual committee of awards, composed of Council members, whose duties shall be to evaluate opinions of local sections and advise the Council if changes in policies seem desirable.

(f) To recommend to the Executive Committee a permanent policy regarding the granting of honorary citations.

H. C. Diehl, *Chairman*
The Refrigeration Research Foundation
200 Midland Bldg.
Colorado Springs, Colo.

W. H. Cook
Division of Applied Biology
National Research Council
Ottawa 2, Ont., Can.

G. F. Garnatz
Kroger Food Foundation
1212 State Ave.
Cincinnati 4, Ohio

H. T. Griswold
Owens-Illinois Glass Co.
P. O. Box 3431 Rincon Annex
San Francisco 19, Calif.

A. N. Prater
Gentry Division
Consolidated Grocers Corp.
Box 2076 Terminal Annex
Los Angeles 54, Calif.

S. C. Prescott
77 Massachusetts Ave.
Cambridge 39, Mass.

C. L. Smith
Continental Can Co.
4645 W. Grand Ave.
Chicago 39, Ill.

R. B. Wakefield
Gerber Products Co.
Fremont, Mich.

J. G. Woodroof
Georgia Experiment Station
Experiment, Ga.

COMMITTEE ON FOOD ENGINEERING AWARD

This Committee is responsible for selecting the recipient of the biennial Food Engineering Award.

The next award under this grant will take place at the 1955 Annual Meeting. For this reason, appointment of this Committee has been deferred until 1954, at which time the appointment will be made by the incoming president.

(Continued on page 22)

ROSTER OF 1953-54 COMMITTEES

(Continued from page 21)

MONSANTO AWARD COMMITTEE

Objective: To select the recipient of the Monsanto Award of $100.00 for the best organization and presentation of a technical paper at the 1954 Annual Meeting.

C. O. Ball, *Chairman*
New Jersey Agricultural
Experiment Station
New Brunswick, N. J.

S. Leonard
630 Anderson Road
Davis, Calif.

M. E. Parker
Illinois Institute of
Technology
3300 S. Federal St.
Chicago, Ill.

PRESCOTT AWARD COMMITTEE

Objective: To select the 1954 recipient of the Samuel Cate Prescott award of $100.00 established by the Northeast Section of the Institute of Food Technologists. The award is granted to the student presenting, for this competition, the best written account of a research project in the field of food technology.

J. Donovan, *Chairman*
Artisan Metal Products Inc.
73 Pond St.
Waltham 54, Mass.

G. Mackinney
University of California
339 Hilgard Hall
Berkeley 4, Calif.

R. R. Legault
Department of Agricultural
Chemistry
State College of Washington
Pullman, Wash.

1954 ANNUAL MEETING SYMPOSIA

General Papers: Dr. Arthur N. Prater, Gentry Div., Consolidated Grocers, Los Angeles.

Fruit and Vegetables Research: John H. MacGillivray, Univ. of California, Davis.

Flavor Changes as Influenced by Applied Chemicals: Charles H. Mahoney, National Canners Assoc., 1133 20th Street, N. W., Washington 6, D. C.

Food and Drug Standards: Charles W. Kaufman, Kraft Foods, 500 Peshtigo Court, Chicago 90.

Citrus Concentrates: W. R. Roy, Minute Maid Corp., Plymouth, Fla.

Basic Investigations in Food Science: Aksel G. Olsen, General Foods Corp., 11th and Hudson, Hoboken, N. J.

Consumer Testing: Helen L. Hanson, Western Regional Research Laboratory, Albany 6, Calif.

Marketing Problems: Roy H. Walters, General Foods Corp., 250 Park Avenue, New York City.

Special Purpose Foods: Ernest Geiger, 3842 Monteith Drive, Los Angeles 43.

Seafood and Seafood Products: Karl Envoldsen, Envoldsen Shrimp, Inc., 1200 West 9th St., Cleveland 13.

Wine and Wine-tasting: Harold W. Berg, Univ. of California, Davis.

Food Engineering: Curtis E. Maier, Continental Can Co., Inc., 4645 West Grand Ave., Chicago 39.

What's New in Food Packaging: Kenneth W. Brighton, American Can Co., Maywood, Ill.

Pectin and Pectic Materials in Food Processing and Preservation: Reese H. Vaughn, Univ. of California, Davis.

Frozen Foods: Dr. K. G. Dykstra, Birds Eye Division, General Foods Corporation, 162 S. Main St., Albion, N. Y.

Advances in Fruit and Vegetable Dehydration: Dr. J. R. Wagner, Qm. Food and Container Institute, 1819 West Pershing Rd., Chicago.

Annual Meeting Bulletin Board

LOS ANGELES—A FOOD PRODUCING AND PROCESSING EMPIRE

Food technologists, fortunate enough or wise enough to be in attendance at the Annual Meeting in Los Angeles, June 27 through July 1, 1954, may not know that Los Angeles County has been the leading agricultural county in the nation for more than forty years. Rich and varied farm products are also available from nearby counties and a multitude of processors have concentrated their activities in this fertile area. The several hundred food plants established in the county have helped increase the industrial stature of Los Angeles to the point where it is the third most important manufacturing center in the nation. This is a region worth a food technologist's time in getting acquainted with.

Food processing industries in the Los Angeles vicinity are second only to aircraft and other transportation equipment manufacture. In all probability, Chicago is the only center in the nation exceeding Los Angeles in value of food processing. The southland city has gained the title of the sea food canning capital of the world. Meat packing, fruit and vegetable dehydrating and freezing, and citrus processing all contribute to an impressive and varied industry.

Canning of Fruits, Vegetables and Sea Foods:

Abundance and quality of agricultural production in the Los Angeles area led to the early establishment of fruit and vegetable canneries. Later, dehydrators and their quick freezing plants became an integral part of this food processing industry. In more recent years, the need to feed an additional ten or fifteen thousand people who come to California each month has increased the demand for fresh fruits and vegetables and many canneries have moved to other areas of California to take advantage of other sources of raw materials. The canneries remaining in the Los Angeles area have shifted their operations to feature items still available such as citrus, tomatoes, sea food and numerous specialties.

In 1951, Los Angeles County processors packed over 13,000,000 cases of food. The 200 different products were valued at $93,000,000. Diversity of pack is surprising; the list includes such items as canned abalone, a wide assortment of baby food, fruit nectars, pickles, Chinese and Mexican dishes, jams and jellies. The food technologist and his family can do a lot of private organoleptic testing of exotic flavors in this region.

The commercial fishing fleet based at Los Angeles harbor provided nearby canneries with enough tuna and other sea food to pack more than 6,000,000 cases in 1951. Value: $58,000,000. In addition, large quantities of sea food products are quick frozen. California supplied 10% of the national pack in 1951; much of this came from Los Angeles County freezers.

Meat Packing at Los Angeles:

California, you may not know, is the leading cattle and lamb slaughtering state. It exceeds even Illinois or Iowa. In 1952, over 1,800,000 head of cattle and 1,872,000 head of lambs and sheep went to the slaughterhouse in this state. Perhaps due to the warm all-year climate, Southern Californians consume more beef and lamb per capita than the national average, but less pork. Los Angeles County now ranks third among the meat packing centers of the nation. Some 50 slaughterhouses operate in the County; over 150 meat packers and processors work under state or federal inspection. In addition to local slaughter, large quantities of dressed meat are shipped in from surplus areas in the Middle West. Despite this huge packing industry, California is, of course, a deficit producing region for cattle, hogs, poultry, butter, eggs, and cheese. Supplemental

(Continued on page 24)

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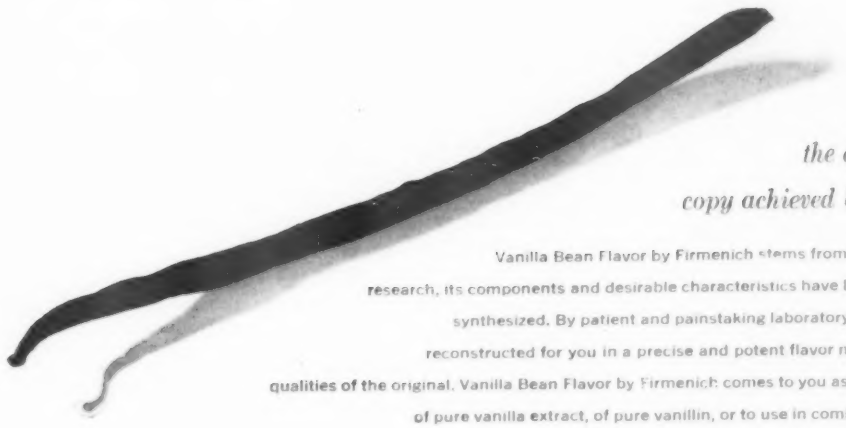

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ANNUAL MEETING BULLETIN BOARD

(Continued from page 22)

supplies of these must be moved into the Los Angeles metropolitan area to meet the demands of the 4,900,000 people living there.

Vegetable Dehydration:

Dehydration of vegetables returns fewer dollars than the big industries mentioned, but it is still a useful and periodically important activity. Several sizeable operators in the Los Angeles area dehydrate for national distribution such items as chili peppers, onions, and garlic along with vegetables of all types for soup mixes. Drying of fruit is not widely practiced because of the lively demands of the fresh fruit markets and the canneries. But some grapes are dried for raisins in Southern California; apricots, peaches, prunes, pears, and apples are dried in considerable volume.

Freezing of Fruits, Vegetables, and Juices:

Relatively new is the practice of quick freezing fruits and vegetables but it has been extensively employed in the Los Angeles area for a long time. From original techniques developed by food technologists for lima beans, spinach, strawberries, broccoli, cauliflower, and peas, quick freezing has been adapted to preserving orange juice concentrate, sea food products of all types, baking goods, meat and poultry products, foreign dishes, and still other specialty items. California's share of the national output of frozen fruits and vegetables (excluding citrus) increased from 4% in 1940 to 24½ in 1951. Citrus processing plants located mainly in Southern California provide one-fifth of the nation's pack of frozen orange juice concentrate and 100% of the frozen lemon and lemonade. More than twenty substantial quick freezing companies operate in the Los Angeles area plus a number of smaller specialty processors. Most widely accepted of the frozen products in the nation today is frozen orange juice concentrate. Southern California processors face stiff competition from Florida but freezers of orange and lemon products are active in the Los Angeles area. Higher costs for citrus fruit in Southern California place local processors at a disadvantage and hence Florida will probably continue as the major factor in the citrus juice market. Southern California will likely continue to emphasize the production of fresh fruit.

Processing Trends in Southern California:

Food processing will continue to be important in Los Angeles County, but sources of fruits and vegetables will be affected in future years by (1) production trends, (2) population and industry expansion and (3) the fact that agricultural areas will be pushed farther away from the city. As an example of a shift, already evident, citrus acreage in Los Angeles County is being removed at the rate of 1,500 to 2,000 acres annually. Most of this vacated acreage is going into residential subdivisions or industrial plants, but some marginal tree crops are being replaced with other crops. Despite crop losses and shifts, the value of agricultural production in Los Angeles County will remain high for a number of years because more valuable crops are being substituted for displaced ones and dairy production continues high.

Food technologists are well aware that many technological innovations now in common use in the food processing business had their start in California's food industry. Through efforts of the research staffs of larger food processors, the USDA, and the University of California, many important advances have been made in improving preserving techniques. Food processing is an integral part of the Los Angeles agricultural and industrial empire. The $300,000,000 added to Los Angeles County income annually by food processing is an important factor in the growing wealth and prosperity of this rich region. A great deal of profitable "collateral study" can be done by the food technologist who will take the time, before or after the annual meeting, to have a look around Los Angeles and vicinity.

It will doubtless be of interest to those heading west next summer that an interesting program relating to Armed Forces' feeding problems will be presented at the annual meeting of the Research and Development Associates, Food and Container Institute, scheduled for June 23, 24, 25, 1953, at the Hotel Biltmore, site of the IFT meetings.

Answer to the question—"Where shall I send the abstract of my proposed paper?"—will be found in the September, 1953, issue of FOOD TECHNOLOGY. Names and addresses of symposia leaders and of the general chairman will be found in brief form in this issue, page 22.

Inadvertently, the symposium on frozen foods was not clearly identified with the announcement of the technical program printed in the September issue. There will definitely be a frozen food symposium. Those who propose to present papers in this field should write to the chairman, Dr. K. G. Dykstra, Birds Eye Division, General Foods Corporation, 162 South Main Street, Albion, New York.

Regional Section News

GREAT LAKES SECTION

The Section will hold three meetings during 1953-54. Tentatively, the first meeting is scheduled for November 6 in Cleveland, Ohio; the winter meeting will be in Detroit, Mich., probably on January 15; and the spring meeting is slated for Battle Creek, Mich., either April 9 or 16. A cordial invitation is extended to members of other Sections of the Institute to attend any or all of these meetings. Anyone desiring more information may obtain same by writing to H. C. Scott, Secretary, Great Lakes Section, IFT, c/o Owens-Illinois Glass Co., P. O. Box 1035, Toledo 1, Ohio.

WESTERN NEW YORK SECTION

The Annual Fall Meeting was held on Friday, September 18, 1953, in the General Brock Hotel, Niagara Falls, Ontario, Canada. It took the form of an afternoon and dinner meeting. A glance at the following program will reveal the interesting papers presented and topics discussed:

"The Better Job we are Doing in Pest Control," Dr. C. O. Eddy, Director of Research and Development, Niagara Chemical Division, Food Machinery and Chemical Corporation, Middleport, N. Y.

"Food Industries in Our Area," Mr. Angus Young, Chief Chemist, Christie, Brown, and Company, Toronto, Canada. Mr. Fred Ziman, Food Technologist, Old Dutch Foods, Inc., Buffalo, N. Y.

"The Chemical Behavior of Antioxidants in Food Products," Dr. R. A. Chapman, Food and Drug Laboratories, Department of National Health & Welfare, Ottawa, Canada.

"How Shall We Train Our Food Technologists"?

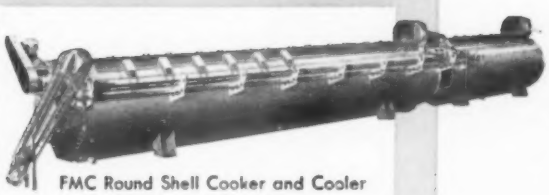
Panel Members:

Dr. Doreen Smith, Food Chemistry Department, University of Toronto, Toronto, Canada.

Mr. William Bayley, Food Technologist, Campbell Soups, Ltd., Toronto, Canada.

Dr. Walter L. Clark, Assistant Professor of Biochemistry, School of Nutrition, Cornell University, Ithaca, N. Y.

(Continued on page 26)



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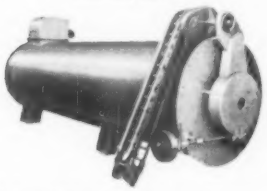
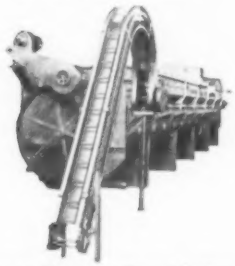


FMC Round Shell Cooker or Cooler with left side positive feed



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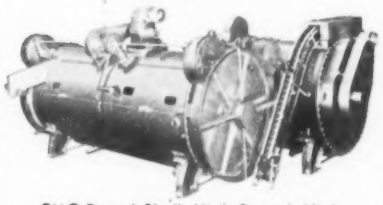

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REGIONAL SECTION NEWS

(Continued from page 24)

Dr. Kenneth G. Dykstra, Birds Eye Laboratories, Albion, N. Y.

Annual Business Meeting.

Dinner.

"The Perspicacious Palate, or How to Feed with Pleasure," Dr. R. K. Larmour, Director of Research, Maple Leaf Milling Company, Toronto, Canada.

Dr. Hucker honored. At the same meeting a distinguished Past President of IFT was honored. Dr. Carl Pederson, who presided at this ceremony, spoke as follows:

A short time ago I received a request from Colonel Lawrence, Executive Secretary of the Institute of Food Technologists, to present this gavel to one of our members who is a Past President of the Institute. Our Western New York Section is singularly honored in having with us not only a past president, but the one who in a large measure was responsible for the early organization and development of the Institute.

At the American Public Health Association meeting in New Orleans in 1936, a small group of chemists and bacteriologists met at Arnaud's in New Orleans to discuss the policy of the then new journal, *Food Research*. This led to a discussion of a subject that had been in the minds of a number of people for several years—to organize chemists, bacteriologists, engineers and other scientists whose common interest was in a scientific approach to the production and handling of food products. This discussion differed from all others that had been held before in that this one was ultimately to bear fruit.

In the spring of 1938 when Dr. Hucker returned from New Zealand, he, Dr. Tressler and others discussed this problem further. As a result, on August 5, 1938, a meeting was held in Geneva, New York, with 16 food technologists present. As a result of this conference, it was proposed that opinions be solicited from a number of qualified persons regarding the advisability of such an organization. In September 1938, 184 letters were sent out to various scientists throughout the country to gather their opinions. Within a short time 147 replies had been received, and, with but one exception, all felt the need of such an organization.

On January 16, 1939, 20 scientists conferred in New York City where it was decided to coordinate opinions and different avenues of approach to food problems through a national association to be known as the INSTITUTE OF FOOD TECHNOLOGISTS. Organization committees were appointed and a tentative constitution was presented. It was agreed that the organization of the INSTITUTE OF FOOD TECHNOLOGISTS would be completed during a Food Technology Conference to be held June 28 to July 1, 1939 in Cambridge, Massachusetts. At this meeting, Dr. Prescott was elected President, Dr. Newton, Vice-President and Dr. Hucker, our honored guest, Secretary-Treasurer. This simply meant that Dr. Hucker would continue the activities which he had carried through for over a year in the coordination of thinking of various individuals. Within a short time, there were some 200 members, and when Dr. Hucker resigned as Secretary-Treasurer in 1947, the Institute had grown to a membership of over 3,000.

Dr. Hucker was honored by the Institute by being elected President for the year 1947-1948. Dr. Hucker served the Institute of Food Technologists through those trying days of organization and through the period of rapid growth. He has dealt intelligently and diplomatically with many of the problems that have arisen in the organization and growth of the Institute. It goes without saying that he has a greater knowledge of the Institute than any other member, a knowledge obtained by the vast amount of work that he *gave* to the Institute.

In view of our long and pleasant association, it is indeed a pleasure to me to have been given the honor of presenting this gavel to you, Dr. Hucker, commemorating your presidency of the Institute of Food Technologists during the year 1947-1948.

Cook's Night Out—that's the theme which was taken by the Buffalo Area group at the first dinner meeting held on October 7 at the Kathryn Lawrence Restaurant, Buffalo, N. Y. Special guests were wives and sweethearts of members. The guest speaker, Mr. C. W. Thomas, Jr., Merchandising Manager, Eastern District, Owens-Illinois Glass Co., took for his topic: "We Can Get Too Smart" and, in addition, showed a movie: "Glasstown, U. S. A." Mr. Thomas, with his many years of experience in merchandising many and varied foodstuffs, made his audience appreciate more fully the "know how" and planning that is necessary to architect an attractive package.

PHILADELPHIA SECTION

The last meeting of the 1952-53 season was held May 19, at Drexel Institute. An excellent dinner was served. Contributing to the excellence of the dinner was chocolate from Suchard Chocolate Co., strawberry preserve from American Preserves Co., and ice cream from Abbott's Dairies. After the dinner a drawing for a door prize was held. The prize was a frozen turkey from Wm. H. Oldach Co. Next on the program was "The Inside Story of a Cake," a motion picture from Swift & Co. showing the change taking place in a cake during the baking operation.

The proposal of the Baker Memorial committee was that a plaque and award of $25.00 be given to an outstanding student in the Food Technology field to study each year. The award is to be made the first year to a student from the University of Delaware; the second year to a student from Drexel, and the third year to a student from Temple. It will be given in the same order thereafter. The student to receive the award is to be selected by a group of professors at the school designated to receive the award.

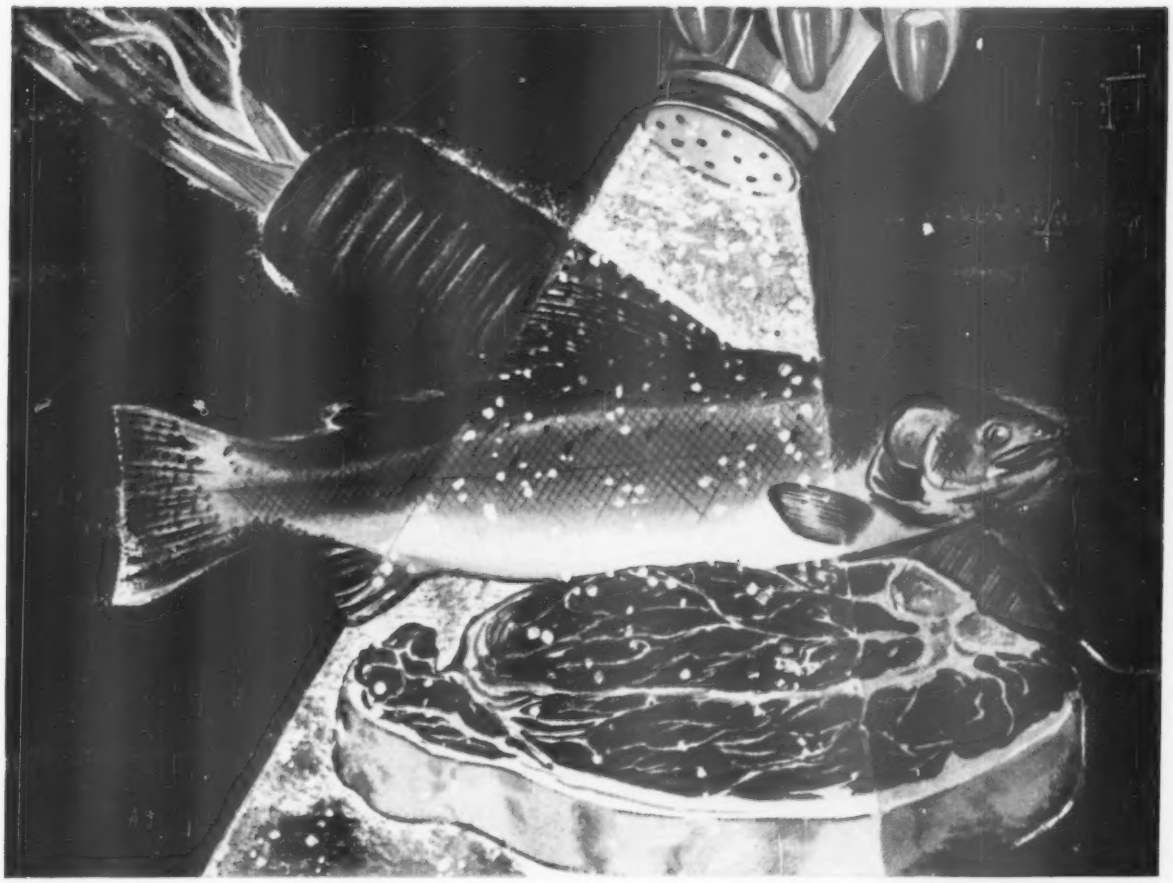
Mr. George Carlin of Swift & Co., gave a very interesting talk on the processing of fats and oils, and the use of fats and oils in the food industry.

The first meeting of the 1953-54 season was held on Tuesday, October 6, 1953, with dinner at the Faculty Club, Institute of Technology. After dinner a sound movie "The President Visits Williamsburg" was shown. Honorable Willard S. Hagar, Deputy Secretary of Agriculture of the Commonwealth of Pennsylvania, was the speaker of the evening. Mr. Hagar spoke on the subject, "What the Food Technologist Should Know About Pennsylvania's Food Standards and Regulations"—It was a most instructive presentation.

PERSONNEL

DR. CHARLES R. STUMBO accepted and is now occupying a research post with the H. J. Heinz Co., Pittsburgh, Pennsylvania. Dr. Stumbo was professor of horticulture, Washington State College, Pullman, Washington, prior to transferring to his position with the H. J. Heinz Co.

DR. R. R. LEGAULT, formerly of the University of Illinois Food Technology Department, received a professorial appointment to the faculty of Washington State College, Pullman, during the summer and has taken up his professorial duties at that institution.



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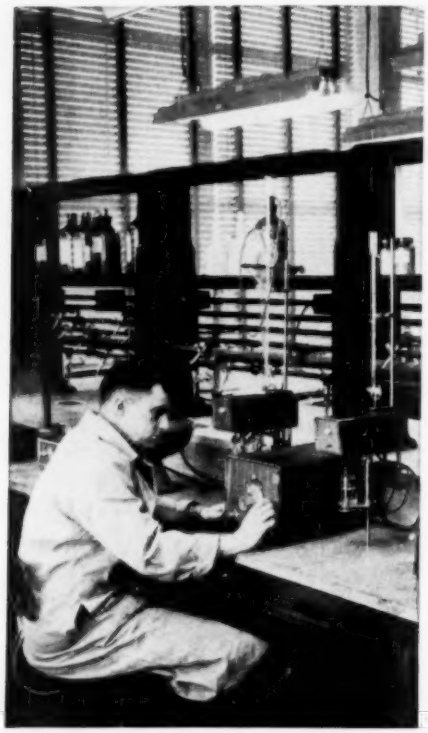

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Low Temperature, High Speed Rendering—The Kingan Process[a]

W. R. DAYEN, K. M. CHRISTENSEN AND R. E. MORSE[b]
Research Laboratories, Kingan & Co., Indianapolis, Indiana

(Manuscript received June 1, 1953)

The Kingan Flash Rendering Process is based on the release of oil from tissue through comminution to sub-cellular dimensions. Comminution is performed at a temperature of approximately 140° F. Separation of the oil from the tissue solids and water is accomplished by centrifugation. The characteristics and operating conditions of the equipment in the processing of beef or pork fat are described together with the factors which must be considered in the design of large capacity rendering systems. The process has been found to improve both quality and yield of animal fats. In addition the process reduces manpower and floor space requirements, and lowers both operating and capitalization costs. Experimental evidence indicates that this rendering process is applicable to vegetable and marine oils.

Edible animal oils have been in a severely declining market since the end of World War II. One of the reasons for the failure of these oils to maintain and improve their economic position is found in the fact that the market has gradually changed to demand a bland, odorless, edible oil of good keeping quality. In general, vegetable oils have successfully met this need. Much effort has been put forth in recent years by the edible animal oil industry to produce a bland, light-colored lard or oleo stock of exceptional stability.

Some time ago work was initiated in our laboratories to reach this objective. Work was begun with fats of beef origin to meet local conditions. However, the overall objective was a process which would be applicable to all animal fats.

PROCESS STUDIES

All systems for rendering animal fats attempt to release fat by rupturing the proteinaceous envelope containing the fat. Among the fat rendering processes studied were those rupturing the cell wall by alkali digestion, etc. *(2)*, enzymes *(6)*, comminution combined with low temperatures and high pressures *(1)*, low temperature shock treatment *(7)*, high velocity impingements at relatively low temperature and pressure *(5)*, solvent extraction *(12)*, and fine comminution combined with low temperature *(4)*. The lack of adequate information on comparative costs, yields and quality on these and other systems of rendering, as has been pointed out by Vibrans *(11)* and re-emphasized by Dormitzer *(3)*, made evaluation most difficult. For one reason or another none of the above rendering methods were wholly acceptable and adaptable to our use.

Preliminary work indicated that low temperature rendering improved color as pointed out by Swift and Hankins *(10)*; odor and free fatty acid content improvement could be achieved by shortening the in-process time; and that yield could be increased by comminuting the fat as pointed out by earlier work of the American Meat Institute *(8)*.

The process. The process developed from these basic facts is a relatively simple continuous one-pass operation. Figure 1 is a flow diagram for the Kingan process designed for the rendering of beef fats into oleo stock. The fat-bearing tissue is reduced by grinding to a maximum particle size of one-quarter inch. The ground fat-bearing tissue is heated to flowability in a water jacketed surge tank, and pumped through a heat exchanger where the proteinaceous fraction is coagulated at about 140° F. No water is required or added during the process. Next, the flow is directed to a precision type hammer mill where the heated fluidized fat is completely rendered by reducing the particle size to diameters of 50-200 microns. The fluid is then brought to proper centrifuging temperature and clarified into component parts of oil, water, and solids, by a one stage 3-phase centrifugal unit. Solids resulting from this process are present as in a dilute water slurry, which can probably be readily separated by shaker screen. Solids are high quality protein and are probably satisfactory for edible purposes. They should not be confused with "cracklings" from present rendering processes.

Figure 2 shows a flow diagram of a conventional rendering process for the manufacture of oleo stock. The operational sequence is to chill the fats overnight, grind the chilled fats, cook the ground fats in a jacketed kettle for one or 2 hours, settle in this tank for one or 2 hours, syphon off the oil into a second jacketed kettle where after one or 2 hours of quiescent clarification the finished oleo stock is drawn off.

[a] Presented before the Thirteenth Annual Meeting of the Institute of Food Technologists, June 22, 1953, Boston, Massachusetts.

[b] Present address: Wm. J. Stange Co., Chicago, Ill.

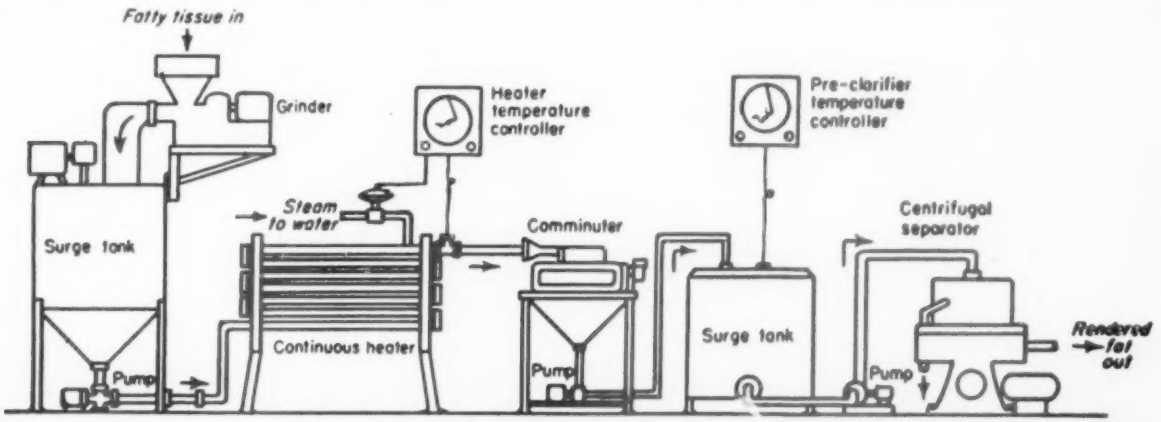

Figure 1. The Kingan flash rendering process.

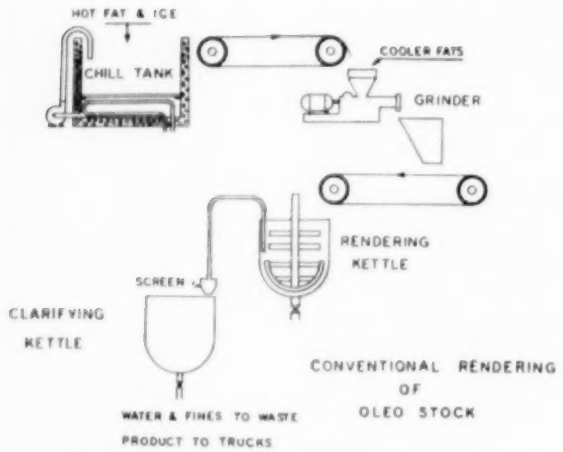

Figure 2. Conventional oleo rendering process.

An operational comparison of the new process and the old process is shown in Table 1.

Flexibility. The Kingan process as presented in Figure 1 is directly adaptable to the production of lard from soft pork fats. For those types of pork partially covered by skin, equipment other than a grinder is required to achieve the initial size reduction. A Kingan process unit designed for all lard production has a tandem unit of 2 different pieces of equipment achieving the initial size reduction. The capacity for the same unit in the Kingan process is 50% higher for pork fats than for beef fats. This is true because of differences in operating temperatures, type and quantity of protein, melting points, specific heats and viscosities. The temperature at which oleo stock is rendered is controlled by Government regulation (*9*) and cannot exceed 170° F. Such temperature restrictions are not present in lard manufacturing.

TABLE 1

Operational comparison:* conventional vs. Kingan process

	Conventional	Kingan
Operations	*Hours*	*Seconds*
Chilling	12-24	None
Grinding	15 min./ton	Continuous
Cooking	1-2	Continuous
Settling	1-2	None
Clarifying	1-2	Continuous
Total time	15-30	30-60
Men required, per shift	6	2
Floor space requirement, square feet	5400	200
Utility costs (steam, water, electricity, refrigeration)	$2-3/ton	15-20¢/ton

* It is difficult to compare time lapse in batch process with continuous — this table shows relative times involved.

The meat-packing industry deals with bulky materials which put a high premium on floor space and hence demands units which have high capacity. Although complete units of the Kingan process can be installed in approximately 200 square feet of floor space, it is possible and practical to separate the 4 individual operations: (a) coarse comminution, (b) heating, (c) fine comminution, and (d) clarification. This permits the use of several areas which need not be more than 5 or 6 feet square. Several economically sized units can be designed, ranging from 1,000 to 10,000 pounds per hour. Such flexibility in installation and capacity is, of course, advantageous to the small producer as well as the larger producer. The larger producer might well be advised to install a unit which has a capacity equal to the rate of development of a particular type of fat in the immediate area where that fat develops. The small producer would be justified in installing one unit to handle his entire production.

Quality. Unlike other systems there is no need to separate the various types of fat from hogs or cattle for successful operation of the process. However, such a separation is frequently desirable because of the differences in melting points and quality. It is shown in Table 2 that the process produces rendered fats of different quality. Color, free fatty acid and stability are dependent upon raw stock quality and age.

The effect of throughput rate on stability is shown in Table 3. Random samples of finished oleo stock were taken over a period of several days, while the unit was operating under on-stream conditions, handling the entire plant output. No attempt was made to identify the samples as to type of fat, warm or cold. It is suggested that increased throughput enhances stability because of less severe heat treatment—hence less destruction of naturally present antioxidants.

TABLE 2

The Kingan process: quality

Kind fat	Type fat	Color (Lovibond)	FFA %	Stability[a] AOM - hrs.
Beef	Warm	10-15y; 1.0-1.5r	0.15-0.20	20-35
	Cold	15-20y; 1.5-2.5r	0.20-0.35	30-50
Pork	Warm	2.0y; 0.23r	0.10	14
	Cold	2.0y; 0.47r	0.25	10

[a] AOM = Accelerated Active Oxygen Method [*Oil & Soap*, **19** (8) 137-139 (1942)].

TABLE 3

The Kingan process: rate study (oleo stock)

Rate lbs./hour	Stability[a] AOM - hrs.
1560	25
1675	31
2562	44
2900	48
3096	55
7800	45

[a] AOM = Accelerated Active Oxygen Method [*Oil & Soap*, **19** (8) 137-139 (1942)].

Yield. Yield data have been collected from pilot plant runs, laboratory controlled production runs, and on-stream production runs. All yield data have given substantially the same results. Yields were calculated by the formula:

$$\% \text{ Yield} = \frac{\text{pounds of finished oil}}{\text{pounds of raw fat}} \times 100$$

Tables 4 and 5 show the yields obtained for oleo stock and lard.

SUMMARY

The Kingan process is a rendering process which achieves the release of the fat from the fat cell almost entirely by mechanically rupturing the cell wall. Operation of the process is improved economically by the

TABLE 4

The Kingan process: yield (oleo stock)

Type fat	% type	Extent of run lbs.	Yield oil %
Caul	100	600	91
Cooler	100	600	90
Caul	52		
Ruffle	21	12,000	92
Cooler	27		
Caul	54		
Ruffle	27	18,000	87
Cooler	19		

TABLE 5

The Kingan process: yield (lard)

Type fat	% type	Extent of run lbs.	Yield %
Leaf	100	400	88
Leaf	100	1,000	94
Fatback	100	1,000	92

addition of heat to the fat and fat fluid at various stages of the system to lower viscosity and thus reduce power requirements, and make centrifugation possible. Substantial improvement has been shown in yield and quality. The process offers flexibility in design and installation. Labor savings are appreciable and utility savings are dramatic. Laboratory and pilot plant evidence indicates that the fundamental technique, the economic mechanical rupturing of the oil or fat containing cell, can be exploited in the marine and vegetable oil fields, as well as in grease, tallow, and bone.

Patent applications have been filed and are being actively pursued. This process is to be made available to the meat-packing industry through one of the large equipment suppliers in the fats and oils field.

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Influence of Piece Size on Production and Quality of Dehydrated Irish Potatoes[a,b]

M. SIMON,[c] J. R. WAGNER,[c] V. G. SILVEIRA,[d] AND C. E. HENDEL[d]

(Manuscript received June 24, 1953)

A study has been made of the effects of piece size and shape, and of calcium chloride treatment on preparational losses, drying time, bulk density, rehydration rate, and relative preference values of dehydrated Irish potatoes. With the Idaho Russet Burbank potatoes employed in this study, the use of calcium chloride for firming made it possible to produce dehydrated potatoes of desired thickness (⅛ inch) which did not slough or become mushy during rehydration and cooking. Calcium chloride treated potatoes of ⅛-inch thickness had the desirable properties of dehydrating more rapidly and to lower moisture content within practicable time than did untreated potatoes of 3/16-inch thickness (present military specification requirement). Preference studies showed that for the dehydrated potatoes produced in this investigation, the calcium chloride treated samples of ⅛-inch thickness were at least as acceptable as those of military specification size requirements, when employed in a variety of recipe items.

[a] Presented at the Thirteenth Annual Meeting of the IFT, Boston, Massachusetts, June 24, 1953.

[b] This paper reports research, part of which was conducted at the Quartermaster Food and Container Institute for the Armed Forces. This paper has been assigned number 439 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsements of the Department of Defense or the Department of Agriculture.

[c] Quartermaster Food and Container Institute for the Armed Forces (Chicago, Illinois) Research and Development Division, Office of The Quartermaster General, Department of the Army.

[d] Western Regional Research Laboratory (Albany, California) Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

It is well known that the size and shape of vegetable pieces have a considerable effect on rate of dehydration, and on moisture content and rehydration characteristics of the dehydrated product. Nevertheless, relatively little published information is available regarding effects of dimensional variations of vegetable pieces on these various factors. Their influence on drying rates of potato strips has been discussed by Ede and Hales *(6)* and by Van Arsdel *(19)*. Davis and Howard *(5)* have reported on the effect of slice thickness on the rehydration rate of dehydrated carrots. Wager and his associates in England *(20)* have reported on the increase in cutting losses sustained in reducing the cross-sectional area of potato strips.

The substantial improvement in keeping quality of dehydrated potatoes resulting from reduction in moisture content has been pointed out by Legault *et al. (11, 12)*, Howard *(8, 9)*, and Caldwell *et al. (2)*. The last-mentioned investigators have stated that the reaction responsible for browning virtually ceases when the moisture content of dehydrated potatoes is reduced below 5%. Similar relationships between moisture content and browning in dried fruits were noted by Stadtman *(18)* in his comprehensive review of non-enzymatic browning in fruit products. In the light of this knowledge, it was felt that reduction in the present military specification moisture tolerance for dehydrated potato dice from 7% to some lower value would undoubtedly prove beneficial with respect to keeping qualities of the product. However, heretofore, it has not been practicable to specify lower moisture values, owing to the

sensitivity to heat damage (non-enzymatic browning) of potatoes of present size requirements ($\frac{3}{8}$ x $\frac{3}{8}$ x $\frac{3}{16}$-inch) when exposed to the higher dehydration temperatures necessary to reduce the moisture levels below 7% within reasonable drying periods. Drying to moisture levels below 7% at temperatures that are safe with respect to heat damage would mean extension of the drying time beyond practicable limits. It is known that reducing piece thickness would permit more rapid drying, would thus make practicable the production of dehydrated potatoes of lower moisture content, and hence, increase resistance to non-enzymatic browning during prolonged warm storage. However, the major difficulty here has been that in reducing the thickness from $\frac{3}{16}$-inch to $\frac{1}{8}$-inch, the product tended toward increased sloughing and mushiness during rehydration and cooking. Other factors requiring consideration were the effects of dimensional changes on preparational losses, bulk density, rehydration rate, and acceptability of the product.

The effectiveness of calcium chloride in firming potatoes and other pectin-containing fruit and vegetable products has long been known, and its use in the canned food industry has been adequately described by Kertesz *(10)*. Control of sloughing in potatoes by application of calcium salts has also be n reported by Personius and Sharp *(16)*, Pyke and Johnson *(17)*, Whittenberger and Nutting *(21)*, and others. Also, in work aimed at control of heat damage in potatoes during dehydration, Campbell and Kilpatrick *(4)* found that in potatoes highly susceptible to mushing, calcium chloride treatment during dehydration processing materially reduced mushiness in the rehydrated cooked product.

The use of calcium for firming thus offered a possible means whereby the production of dehydrated potatoes with superior keeping qualities could be achieved by moderate change in piece size or shape. Because of the importance of dehydrated potatoes in military feeding and of their growing importance for civilian use, a study was undertaken to obtain information with respect to the effects of piece size and shape and calcium chloride treatment on processing losses, dehydration efficiency and quality characteristics of the dehydrated product. The characteristics studied were bulk density, rehydration properties, ease of handling, and acceptability when served in a variety of recipe items.

MATERIALS AND METHODS

Potatoes used throughout the greater part of this study were Idaho grown Russet Burbanks from the late 1951 harvest. Sensory tests were conducted also on dehydrated material from the same variety of potatoes from the late 1952 harvest. The raw material was abrasive peeled,* hand trimmed, diced, washed in cool water, weighed onto trays, and steam blanched for 3 minutes at 212° F. (100° C.), a tray loading of 1½ pounds of blanched potatoes per square foot being employed for all samples. Upon emergence from the blancher the potatoes were sprayed with water or an aqueous solution of calcium chloride, using $\frac{2}{3}$ pound of water or calcium chloride solution per pound of potato. The potatoes were then dehydrated in a cross-tray cabinet drier with dry bulb temperature of 140° F. (60° C.), and wet bulb temperature of 83° to 86° F. (28° to 30° C.). Air velocity was 700 f.p.m. ± 10%.

* Lye peeling was employed in potatoes from the 1952 harvest used for sensory tests.

Preliminary work using a large number of piece sizes indicated that pieces having a cross section less than $\frac{1}{8}$ x $\frac{1}{8}$-inch would be too small from the standpoint of acceptability. Those with cross section of 1 x 1-inch, 1½ x ½-inch, and other similar sizes stuck together during drying and were extremely difficult to separate, even though practically all free surface starch had been removed by thorough washing prior to blanching. Furthermore, dehydrated potatoes of such large cross-sectional area proved to be exceedingly bulky. Preliminary trials showed also that for the potatoes used in this study, suitable firming of pieces of $\frac{1}{8}$ inch thickness could be accomplished by spraying with a solution of 0.50% $CaCl_2 \cdot 2H_2O$ (ACS grade). It is recognized of course that different levels of calcium chloride may be more suitable for varieties of mealy potatoes, and that for potatoes which are "waxy," calcium-firming may not only be unnecessary, but even undesirable. As a result of the preliminary trials it was determined to employ in the principal study pieces of potatoes having a cross-section of $\frac{3}{8}$ x $\frac{3}{8}$-inch and ranging in thickness from $\frac{1}{8}$ to $\frac{5}{8}$-inch; also, potatoes of ½ x ½ x $\frac{5}{8}$-inch dimensions.

Cutting and blanching losses. For determination of cutting losses, a circular pan, 5 feet in diameter, 15 inches in depth, and containing 4 to 6 inches of water was placed under the dicer. A wire basket was placed in the pan in such position as to receive the potato dice from the discharge chute of the dicer. The arrangement was such that all of the dice were caught in the basket and fines passing through the basket trapped in the pan. After the trimmed potatoes had been sliced, the machine was carefully rinsed so that all residual solid material was washed out of the dicer into the basket or pan. Potato dice contained in the wire basket were washed by strong agitation in 2 successive portions of fresh water at about 20° C. (68° F.) until practically all free surface starch had been removed. All of the wash liquids were then combined with the water contained in the pan, and the insoluble material (free starch and fines) allowed to settle. The extracted solubles were determined by evaporating to dryness duplicate aliquots of the supernatant wash water, and the insoluble material by separating from the liquid and drying until moisture free. The combined soluble and insoluble solids found in the wash water are reported as cutting losses.

Leaching losses during blanching were determined by measuring the solids content of the condensate from the blancher and the liquids recovered from the post-blanching spray operation.

Dehydration rate. Drying curves such as those depicted in Figure 1 were determined by periodic weighing of the potatoes (on the tray) during drying. Brown and Kilpatrick *(1)* have reported that this practice does not affect the rate of drying. Dehydration data were obtained for potatoes dried on wire trays and also on wooden slat trays (one inch slats with gaps of approximately $\frac{1}{16}$ inch between slats). Wire screening fastened around and under the wooden trays prevented loss of small pieces.

Moisture content. Moisture contents of the dehydrated products were measured both by the 6-hour vacuum oven method prescribed by the military specification *(14)*, and by the 40-hour, —40 mesh, vacuum oven method of Makower *et al. (13)*. With the potatoes used in this study, moisture values found by the 6-hour method were lower than those obtained by the 40-hour method by 1.6 to 2.3% (average 2%). This difference between the 2 methods is in accord with differences ranging from 1.2 to 2.4% observed with other lots of dehydrated potatoes. Although the specification procedure is much more rapid, the Makower method is more reproducible, and is considered to give values more nearly approximating the true moisture content *(13)*. This may in part be due to the fact that the entire sample is ground to size suitable for the moisture determination with nothing discarded, while in the 6-hour method, the sample is ground and screened, with only the 20-40 mesh portion used in the moisture determination. The coarser particles which are discarded tend to come from the center of the dice, and may sometimes have a higher moisture content than the finer particles which come from the outer portions of the dice. Moisture values indicated in Table 2 and Figure 1 are expressed in terms of the 6-hour method, the one more commonly used, especially in connection with military procurements. Actually, however, these figures

are calculated values obtained by subtracting 2.0% (average difference between the two methods) from the values obtained by the more accurate 40-hour method, the uncertainty from variations in the 6-hour method thereby being avoided.

Bulk density. Bulk density was determined by measuring the weight of dried product at the one liter mark in a container after the filled container had been tapped vigorously 30 times on a laboratory bench. It was determined also by placing a given weight of dehydrated potatoes in a graduated cylinder, tapping the cylinder a number of times on a table, and measuring the volume occupied by the dehydrated product. Constant volume, insignificantly changed by further tapping or by variation in the intensity of tapping, was obtained. The results reported in Table 3 are the averages of sextuplicate determinations.

Rate of rehydration. The apparatus used for rehydration rate work was that developed by Morris, Olson, and Bean *(15)* for use with dried beans. It consists of a 250 ml. Erlenmeyer flask connected by a ground glass joint to a 100 ml. graduated flask.

In the method of Morris, *et al.*, measured quantities of dehydrated material and water are placed in the Erlenmeyer flask which may be kept in a water bath of desired temperature. The apparatus is inverted periodically, permitting the water to flow into the cylinder. The solid material is prevented from entering the cylinder by a perforated disc placed between flask and cylinder. The amount of water absorbed by the dehydrated product at any given time is determined by subtracting the quantity draining into the cylinder from that originally placed in the apparatus.

The procedure as applied in this study varied from that described by Morris and coworkers *(15)* in that an individual sample was employed for each rehydration time used in developing the rehydration rate curve, whereas Morris *et al.*, using a temperature of 25° C. (77° F.), employed the same sample for each point on their curve. This variation was necessitated by the high rehydration temperatures, 87° C. (189° F.), used in this study. A considerable fall in temperature would occur during removal of the flask and its contents from the hot water bath and inverting it for a one minute draining period prior to measuring the volume of excess liquid. The return to the desired rehydration temperature, upon replacement of flask and contents in the water bath, was very slow. Consequently, in using the same sample for each time interval, it would not be possible to maintain the desired temperature throughout the entire rehydration period. In beginning the rehydration, the potatoes (20 g.) were not added to the apparatus until the water contained in the flask (120 or 150 ml., depending on the expected absorption) had reached the desired 87° C. (189° F.) temperature. Actually, the bath temperature was 90° C. (194° F.); however, sufficient condensation occurred to prevent the contents of the flask from rising above 87° C. (189° F.). Although temperatures of 100° C. (212° F.) would more nearly simulate actual cooking conditions, this higher temperature could not be used, since the steam pressure produced would cause separation of the apparatus, resulting in a loss of water through volatilization.

Water absorption during cooking was measured by a cooking procedure simulating that employed in Army kitchens. One part by weight of dehydrated potatoes (usually 4 or 5 oz.) was added to 5 parts of cool water; the mixture was brought to a boil in 30 minutes and then simmered for 10 minutes. Heating was controlled to give a fairly uniform temperature rise during the 30 minute period. The cooked material was drained for several minutes in a sieve and weighed. Water absorption has been expressed as ratio of cooked to dry weight of potatoes.

Sensory tests. Quality of the dehydrated potato samples of all of the various piece sizes was appraised by serving them in a variety of recipe items. The dehydrated materials, prepared from the late 1951 harvest, were tested as potato salad, hash brown potatoes, and as plain cooked potato dice seasoned only with salt. The judges were instructed to evaluate the samples on the basis of appearance, texture, and flavor, and to rate the products accordingly. A 1 to 9 quality rating scale, ranging from very poor to excellent, was used for scoring.

Supplementary tests were conducted on materials prepared from potatoes of the late 1952 harvest, using only 3 piece size variations; namely, ⅜ x ⅜ x 3/16-inch, ⅜ x ⅜ x ⅛-inch, and ½ x ½ x ⅛-inch. Potatoes of ⅛-inch thickness were treated with calcium chloride for firming. Mashed potatoes from these 3 samples were evaluated by the test method described above, the combined evaluation of appearance, texture, and flavor being reflected in a single numerical score. Quality appraisals were also made on the same 3 products prepared and served as buttered dice and as hash brown potatoes. In this case, however, each of the 3 quality factors—appearance, texture, and flavor—were rated separately, using the same rating scale. Results are illustrated in Tables 5 and 6.

RESULTS

Data shown in Table 7 indicate that there were no significant differences in steam blanching losses among the various samples. Losses ranged from 1.1 to 1.5% of the solids content of the trimmed potatoes, with no apparent correlation between piece size and percent loss. Differences in cutting and washing losses were moderate with the largest losses of 14.1 and 14.0% occurring, as expected, in the smaller pieces, ⅛-inch in thickness. Potatoes of larger piece size, ⅜ x ⅜ x ⅜-inch and ⅜ x ⅜ x ⅜-inch, sustained losses of 9.1 and 8.7%, respectively. Potato dice of intermediate piece size, ⅜ x ⅜ x 3/16-inch were also intermediate in the extent of cutting and washing losses, the losses here being 11.0%. The relationship between piece size and processing losses shown here are in agreement with the yields reported by Wager and coworkers *(20)* working with potato strips of various cross sectional areas.

The effectiveness of reducing piece thickness in accelerating dehydration on both wooden and metallic trays is clearly illustrated in Figure 1 and Table 2, the advantages being especially

TABLE 1

Preparational losses[1] as affected by size and shape of potato pieces

Piece size, inches	Percent solids lost	
	Due to cutting and washing	Due to steam blanching
⅜ x ⅜ x ⅜	9.1	1.1
⅜ x ⅜ x ⅛	8.7	1.4
⅜ x ⅜ x 3/16	11.0	1.3
⅛ x ⅛ x ⅜	14.1	1.4
½ x ½ x ⅜	14.0	1.5

[1] Based on solids content of the trimmed potatoes.

TABLE 2

Influence of piece size and calcium chloride treatment on rate of dehydration[a]

Piece size, inches	Hours of drying required to reach indicated moisture content[b]								
	On wire trays						On wooden trays		
	13%	10%	7%	6%	5%	4%	13%	10%	7%
⅜ x ⅜ x ⅜	5.3	6.7	8.8	11	15		6.2	8.2	
⅜ x ⅜ x ⅛	4.5	5.9	8.0	9.5	12		5.0	6.5	8.2
⅜ x ⅜ x 3/16	3.2	4.1	5.6	6.7	8.3	13	4.1	5.5	6.5
⅛ x ⅛ x ⅜	2.6	3.1	3.8	4.6	5.7	7.5	3.1	3.8	4.5
⅜ x ⅜ x ⅛ (CaCl$_2$)	2.7	3.3	4.0	4.8	6.2	8.5	3.3	4.0	4.7
½ x ½ x ⅜	2.9	3.6	4.5	4.9	6.0	8.0			
½ x ½ x ⅛ (CaCl$_2$)	2.7	3.3	3.8	4.8	5.9	7.5			

[a] Tray loading of 1½ pounds per square foot, air dry bulb temperature 140° F., wet-bulb temperature 84 to 86° F., velocity 700 f.p.m. ± 10 percent.
[b] Six hour vacuum oven method; corresponding values for the 40 hour method are 2.0 percent higher. See text.

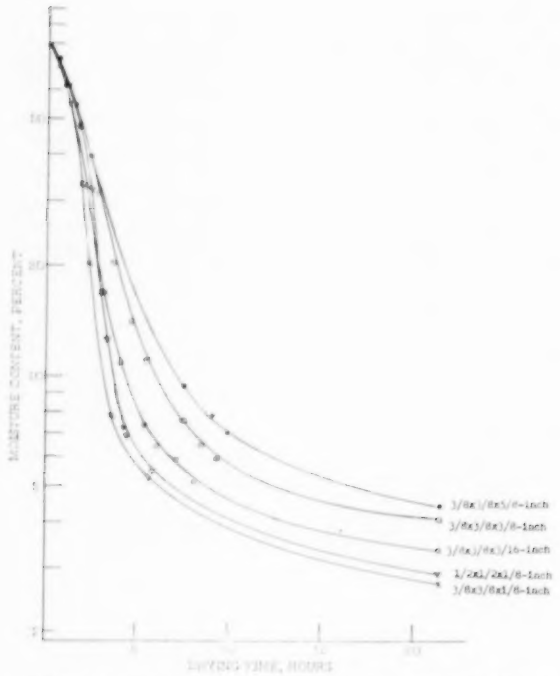

Figure 1. Effect of piece size on rate of dehydration of Irish potatoes at 60° C. (140° F.).

apparent in the later stages of dehydration. The increasing effectiveness of reduced piece thickness, as the moisture content of the product is reduced to lower and lower levels, is in accord with predictions based on the mechanisms of drying at various moisture intervals, and has been briefly discussed by Van Arsdel *(19)*. Particularly noteworthy is the fact that potatoes of $\frac{1}{8}$-inch thickness were reduced to 5% moisture in approximately the same time required to bring the $\frac{3}{8} \times \frac{3}{8} \times \frac{3}{16}$-inch pieces to the 7% moisture level, the maximum allowable by the military specification for dehydrated potato dice. Legault and coworkers *(11, 12)* have shown that at moisture levels of 7% and below, storage life with respect to browning is approximately doubled for each 2% reduction in moisture content. It should be noted also that the calcium chloride treatment, at levels employed in this study, had little effect on the rate of drying.

Bulk density values for the dehydrated potatoes of various piece sizes and shapes are presented in Table 3. With potatoes having a cross-sectional area of $\frac{1}{8} \times \frac{1}{8}$-inch, increasing thickness from $\frac{3}{16}$-inch to $\frac{1}{4}$ or $\frac{5}{8}$-inch had no significant effect on the bulkiness of the products. However, reduction of thickness to $\frac{1}{8}$-inch did result in substantial decreases in density, the $\frac{1}{8} \times \frac{1}{8} \times \frac{1}{8}$-inch products being 91 to 93%, and the $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{8}$-inch products being 82% as dense as the specification size ($\frac{3}{8} \times \frac{3}{8} \times \frac{3}{16}$-inch) product. The importance of bulk density lies in its relationship to space conservation, products of lesser density requiring more space than products of greater density.

TABLE 3
Influence of piece size and calcium chloride treatment on bulk density of dehydrated potatoes

Piece size, inches	Bulk density, gm./cm. cm.	Relative density [1]
$\frac{3}{8} \times \frac{3}{8} \times \frac{5}{8}$	0.318	98
$\frac{3}{8} \times \frac{3}{8} \times \frac{1}{4}$	0.318	98
$\frac{3}{8} \times \frac{3}{8} \times \frac{3}{16}$	0.325	100
$\frac{1}{8} \times \frac{1}{8} \times \frac{5}{8}$	0.294	91
$\frac{1}{8} \times \frac{1}{8} \times \frac{1}{4}$ (CaCl$_2$)	0.303	93
$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{8}$	0.265	82
$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{8}$ (CaCl$_2$)	0.268	82

[1] Value of 100 arbitrarily assumed to $\frac{3}{8} \times \frac{3}{8} \times \frac{3}{16}$-inch product.

One of the most important characteristics of a dehydrated product is its capacity for rapid and complete rehydration. Reduction of piece thickness proved extremely beneficial in this respect, as shown in Figure 2 and Table 4. The time required for absorption of given quantities of water was found to be directly related to piece thickness. Using as an example potatoes varying only in thickness, that is potatoes of $\frac{3}{8} \times \frac{3}{8}$-inch cross section untreated with calcium chloride, the lengths of time required for absorption of 4.0 g. water per g. of dehydrated potato were 43, 69, 94 and 120 minutes for thicknesses of $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$ and $\frac{5}{8}$-inch, respectively. Calcium chloride treatment had no apparent influence on rate of water uptake during the earlier stages of rehydration, but tended to retard absorption during the later stages. This was especially noticeable in the case of $\frac{3}{8} \times \frac{3}{8} \times \frac{1}{8}$-inch pieces, wherein the calcium chloride treated material required 65 minutes, as compared to only 43 minutes, required by the untreated material, for absorption of 4.0 g. of water per g. of dehydrated potato. With potatoes of $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{8}$-inch dimensions, calcium chloride treatment extended the time of uptake of the same amount of water from 45 to 50 minutes. It should be noted, however, that these rehydration times were all less than the 69 minutes required by the sample of $\frac{3}{8} \times \frac{3}{8} \times \frac{3}{16}$-inch dimensions.

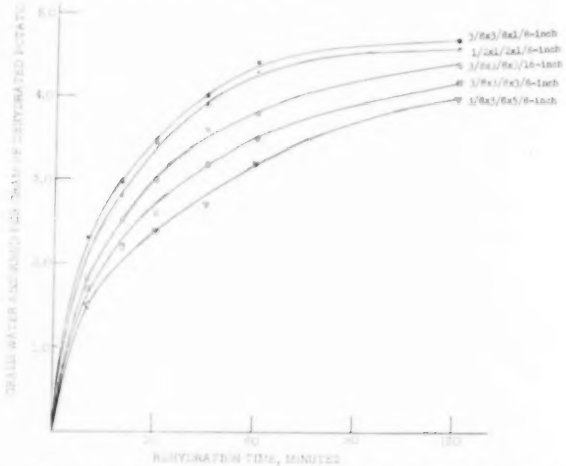

Figure 2. Effect of piece size on rate of water absorption by dehydrated potatoes at 87° C. (189° F.).

The extent of water absorption during cooking by the simulated Army procedure, expressed in Table 4 as ratio of cooked to dry weight of potatoes, paralleled that occurring at 87° C. (189° F.), water uptake again varying inversely with piece thickness. The rate retardation influence of calcium chloride treatment, however, was not apparent here. The smaller pieces ($\frac{1}{8}$-inch thick) untreated with calcium chloride, sloughed badly during cooking and were mushy in texture. The same was true to a somewhat lesser degree for the $\frac{3}{8} \times \frac{3}{8} \times \frac{3}{16}$-inch product. With products of $\frac{3}{8}$- and $\frac{5}{8}$-inch thickness, the surface of the pieces sloughed before the inner portions of the pieces were thoroughly cooked. Although treatment of the smallest pieces with calcium chloride eliminated sloughing, it also increased somewhat the time needed to produce a tender cooked product. Employing the usual simmering time of 10 to 15 minutes resulted in calcium chloride treated products having an excessive number of "hard centers." However, these "hard centers" apparently affected the quality rating of the product only when served as mashed potatoes. It was found that by extension of the simmering time to 20 minutes for the $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{8}$-inch pieces and to 25 minutes for the $\frac{3}{8} \times \frac{3}{8} \times \frac{1}{8}$-inch pieces, the number of hard centers could be substantially reduced. The calcium chloride treated potatoes were found capable of withstanding the additional cooking without sloughing or loss of flavor. There is no obvious reason why the $\frac{1}{8}$-inch pieces of $\frac{3}{8} \times \frac{3}{8}$-inch cross section should require longer cooking than the pieces of $\frac{1}{2} \times \frac{1}{2}$-inch cross section. Nevertheless,

TABLE 4

Effect of piece size and calcium chloride treatment on rehydration characteristics of dehydrated potatoes

Piece size, inches	Minutes required for water absorption [1] at 87° C. (189° F.)			Ratio of cooked to dry weight of potatoes [2]
	3.0 g. water	3.5 g. water	4.0 g. water	
⅜ x ⅜ x ⅜	51	80	120	3.4:1
⅜ x ⅜ x ⅜	37	57	94	3.9:1
⅜ x ⅜ x 3/16	29	43	69	4.2:1
⅜ x ⅜ x ⅛	19	29	43	4.5:1
⅜ x ⅜ x ⅛ (CaCl₂)	21	37	65	4.4:1
½ x ½ x ⅛	21	31	45	4.4:1
½ x ½ x ⅛ (CaCl₂)	18	31	50	4.6:1

[1] Grams water per gram of dehydrated potato.
[2] Prepared by simulated Army cooking procedure.

the same phenomenon was observed to occur in the case of products prepared from both the late 1951 and late 1952 potato harvests. It might also be related in some way to the slower rehydration rate noted for the treated ⅜ x ⅜-inch product, as indicated in Table 4.

Data in Table 5 indicate that the calcium chloride treated potatoes of ½ x ½ x ⅛-inch dimensions were considered best in all recipe items except mashed potatoes. The 2 largest piece sizes received unfavorable ratings when served as boiled dice seasoned only with salt. All samples rated highly when served as potato salad, the calcium containing samples scoring highest. As hash brown potatoes, all samples rated fairly well with no apparent relationship between score and piece size. Most noteworthy is the effect of calcium chloride treatment in consistently improving the quality rating of potatoes so treated over that of the untreated material of corresponding piece size. This improvement may undoubtedly be attributed to increased firmness and better retention of shape. When served as mashed potatoes, the ⅜ x ⅜ x 3/16-inch and the ½ x ½ x ⅛-inch products rated equally well, with the ⅜ x ⅜ x ⅛-inch product scoring well but slightly under the other two. Comments received from judges in these tests indicated this small difference in rating to be due to greater lumpiness in the ⅜ x ⅜ x ⅛-inch material. It is quite conceivable, however, that the problem of lumpiness could be partially relieved by employing lower levels of calcium chloride.

In Table 6 are presented the results of tests in which each of the quality factors, appearance, texture, and flavor were rated individually. The calcium chloride treated sample of ½ x ½ x ⅛-inch dimensions scored highest in appearance and flavor, both as buttered dice and as hash brown potatoes. With respect to texture this sample scored at least as well as either of the other 2 samples.

DISCUSSION

It has been demonstrated that, at least for the type of potatoes used in this investigation, the tendency toward sloughing and mushiness of a dehydrated product of ⅛-inch piece thickness could be controlled by treatment with calcium chloride prior to dehydration. The development of calcium firming would thus make practicable the use of dehydrated potatoes of the narrower dimensions necessary for production of a product having a moisture content substantially below present levels, thereby increasing the resistance of the product to non-enzymatic browning during prolonged warm storage.[9] The sensory test results indicate that the acceptance of the product would not be adversely affected by retention of the ⅜ x ⅜-inch cross-sectional dimensions, and that increasing the cross-sectional dimensions to ½ x ½-inch would result in even greater acceptance of the product.

The principal apparent disadvantage in reducing piece thickness from 3/16 to ⅛ inch, and enlarging the cross-sectional dimensions from ⅜ x ⅜-inch to ½ x ½-inch, would be the increase in product bulkiness, consequently increasing the space and container requirements per unit weight of product. However, this may be largely compensated for by the higher solids content of the thinner products (owing to more efficient dehydration) and their capacity for more complete rehydration providing a larger quantity of cooked edible material per weight of dry product. Furthermore, the disadvantage of increased bulkiness may be far less important than the improvements in rehydration characteristics, keeping quality, ease of handling during preparation and possibly acceptance.

TABLE 6

Effect of piece size and calcium chloride treatment on quality factors of dehydrated potatoes

Recipe item	Piece size, inches	Quality rating score [3]		
		Appearance	Texture	Flavor
Buttered dice	⅜ x ⅜ x 3/16	5.3	6.6	6.2
	⅜ x ⅜ x ⅛ (CaCl₂)	6.3	6.0	6.2
	½ x ½ x ⅛ (CaCl₂)	6.3	6.6	6.7
Hash brown potatoes	⅜ x ⅜ x 3/16	6.6	6.6	6.7
	⅜ x ⅜ x ⅛ (CaCl₂)	6.6	7.0	7.0
	½ x ½ x ⅛ (CaCl₂)	7.0	7.0	7.2

[3] Average of 20 judgments; a score of 3 denotes poor, 5 denotes fair, 7 denotes good, and 9 denotes excellent.

[9] The results of preliminary bin drying studies being conducted at the Western Regional Research Laboratory (7) indicate that by extension of bin drying time under controlled temperature and humidity conditions, it may be possible to reduce the moisture content of dehydrated potatoes of specification size requirements (⅜ x ⅜ x 3/16-inch), by as much as 2% below that presently allowed by the specification, without heat damage. If proven practicable, extension of bin drying time would thus provide a possible alternative or supplementary means of achieving lower moisture levels.

TABLE 5

Effect of piece size and calcium chloride treatment on quality rating of dehydrated potatoes served in a variety of recipe items

Recipe item	Number of judgments	Average Quality Rating — Piece size, inches						
		⅜ x ⅜ x ⅜	⅜ x ⅜ x ⅜	⅜ x ⅜ x 3/16	⅜ x ⅜ x ⅛	⅜ x ⅜ x ⅛ (CaCl₂)	½ x ½ x ⅛	½ x ½ x ⅛ (CaCl₂)
Cooked dice, salt added	12	4.8	4.7	5.9	5.4	6.0	6.8	7.8
Potato salad	20				6.8	7.0	6.8	7.4
	20	6.3	7.0	6.7		6.7		
	20		6.1	6.4				6.9
Hash brown potatoes	10	5.8	6.6	6.6	5.6	6.1	5.8	7.2
Mashed potatoes	40			7.3		6.9		7.2

[4] A score of 3 denotes poor, 5 denotes fair, 7 denotes good, and 9 denotes excellent.

Extensive work with other types of potatoes will be necessary, however, before the usefulness of calcium firming can be properly evaluated. In previous work *(3)* with potatoes highly susceptible to mushing and cut as "full dice" (⅜ x ⅜ x ⅜-inch), there was found a wide variation in the calcium level requirement within a given lot of potatoes, some dice becoming too firm with a given calcium treatment, while others within the same sample remained mushy. This variation within an individual sample was not observed in potato pieces of ⅛-inch thickness with any of the raw materials thus far studied.

SUMMARY

Calcium chloride treatment during dehydration processing of Idaho Russet Burbank potatoes made possible the production of dehydrated potatoes of desired thickness (⅛-inch) which did not slough or become mushy during rehydration and cooking. Dehydration and rehydration were similarly related to piece thickness, the thinner pieces dehydrating more rapidly, and rehydrating more quickly and more completely than the thicker pieces.

Sensory tests showed that treated potatoes of ⅜ x ⅜ x ⅛-inch dimensions were approximately equal in quality rating to the untreated product of specification size (⅜ x ⅜ x $\frac{3}{16}$-inch), and that treated potatoes of ½ x ½ x ⅛-inch dimensions were rated even more highly, when served in a variety of recipe items. Furthermore, treated products were capable of withstanding more vigorous handling during storage.

The principal drawback in reducing piece thickness from $\frac{3}{16}$ to ⅛-inch and increasing cross sectional dimensions from ⅜ x ⅜-inch to ½ x ½-inch was the greater bulk of the dry product, and a slight reduction in yield, the latter being due to somewhat greater cutting losses.

Results obtained with one type of potato indicate that improvement in quality and stability of the dehydrated product may be achieved by means of calcium chloride treatment. Before the usefulness of this treatment can be firmly established, however, extensive work with other varieties of potatoes will be necessary.

Acknowledgment

The authors express appreciation for the suggestions and assistance of numerous coworkers: at the Western Regional Research Laboratory, to Dr. H. K. Burr, Dr. H. S. Olcott, and to K. T. Williams and other members of the Analytical Section; at the Quartermaster Food and Container Institute for the Armed Forces, to Mrs. Frances H. Lee of the Experimental Cookery Division.

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Antioxidant Treatment for Bacon[a]

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(Manuscript received May 28, 1953)

Determinations have been made of the extent of fat stabilization provided by various antioxidants when injected into bacon bellies or surface coated. Hydroquinone, butylated hydroxyanisole, propyl gallate and citric acid were used individually and in combination. Samples of treated bacon were sliced, packaged, and stored at 0 and 28° F. until rancid. Rancidity evaluation by a trained taste panel did not correlate with chemical criteria. Dipped coatings containing 5.5 and 10% butylated hydroxyanisole in lard gave markedly increased fat stability. Similar results were achieved by injection of aqueous solutions of 0.2% hydroquinone or 0.2% butylated hydroxyanisole. Distribution of antioxidant in raw bacon, cooked bacon, and cooked-out grease was determined by the dipyridyl and dichloroquinonechlorimide methods. While somewhat higher values were obtained by the dipyridyl method, both analytical procedures gave proportional results for antioxidant concentration.

A suitable method of stabilizing animal tissue fats has long been a problem in the food industry *(1)*. The fatty portion of products such as bacon, break down in the presence of oxygen to form peroxides, aldehydes, ketones and other products which produce unpleasant flavors and odors *(2)*. The problem of detection and control of rancidity in such products is further complicated by the heterogeneous structure of the product and the masking effect of salt and smoke on taste and odor.

There has been much discussion of the validity of chemical methods for measuring rancidity in animal tissue fats *(3)*. The best index of rancidity as established by prior work and the following work is obtained from a trained organoleptic panel. Even though the taste and smell senses are probably the most elusive and least clearly defined of the 5 physical senses and are subject to influence by external conditions such as time, temperature, and product appearance *(4)*, trained panels are the best tool for detection of rancidity in bacon.

The addition of a stabilizing agent to an animal tissue fat presents a difficult problem. The antioxidant must meet certain standards *(5, 6)*; namely, it must be capable of interrupting the fat-oxygen reaction chain. Its molecular size must be small enough to readily pass through animal tissue cell walls. It must have a reasonable solubility range to enter both aqueous and fat phases. Although the stabilizer will not react with the aqueous phase, if it is soluble in the aqueous phase the stabilizer will be able to travel through the aqueous channels to reach isolated fatty portions in the heterogeneous product to give a better stabilizer distribution. It must be soluble in an edible medium for dispersion through animal tissue. It must have a high inhibitory efficiency so that low concentrations may be used. It must impart no flavor, color, odor nor toxicity to the product stabilized, and it must be readily available at a reasonable cost.

Suitable stabilizers, a means of introducing them into the product, quantitative measures of concentration, distribution among the raw, cooked, and cooked-out fat, and inhibitory effectiveness were studied and are reported in the following paper.

METHODS

In preliminary tests an injecto-cure machine *(7)* was used for anti-oxidant introduction. This machine is composed of a series of hypodermic needles which pump bacon pickle into bacon. A typical bacon pumping pickle has the following formulation:

71.9% Water
16.8% Sodium Chloride
11.1% Sugar
.2% Sodium Nitrite

Hydroquinone (HQ), butylated hydroxyanisole (BHA), propyl gallate (PG) and citric acid (CA) were studied. The incorporation of HQ, PG, CA, and various combinations into bacon pumping pickle was accomplished by first dissolving the materials in a minimum amount of 95% ethyl alcohol and then preparing a dispersion in the pickle solution.

BHA was first dissolved in a minimum amount of lard then this mixture emulsified in an aqueous solution of 1% Tide. This solution was then injected into the bacon separately from the pickle solution.

The antioxidant concentrations in the pickle were:

0.49 % Hydroquinone
0.20 % Propyl gallate
0.49 % Butylated hydroxyanisole
0.002% Citric acid

Pickle solutions of PG, HQ, and HQ-CA were injected such that the bacon bellies gained 8% in weight. This gave an approximate concentration of 0.016% PG, 0.039% HQ, and in the HQ-CA mixture of 0.039% HQ, 0.0016% CA.

BHA emulsion was injected separately from the pickle solution to produce 0.039% BHA in the product. In the test using CA sodium nitrite was omitted from the pickle solution. CA lowered the pH of the pickle solution such that oxides of nitrogen were evolved.

The treated samples were made from the shoulder end of the bellies while the controls were from the respective flank ends. Duplicate samples were prepared.

After injection all bacon bellies were held for 2 days at 40° F. to allow diffusion of cure and antioxidant. Bellies were then smoked at 125° F. for 18 hours in accordance with usual practices in a meat packing plant.

Next the bacon was chilled to 28° F., sliced and packaged. Each test lot was halved, one stored at 28° F. and the other at 0° F. All samples were stored in the absence of light.

Several series were run using a dip method of introducing the antioxidant. Paired bacon bellies from the same hog were cured in the normal manner using a typical bacon pumping pickle. They were subsequently smoked in a normal manner for 18 hours at 125° F.

After smoking, while the bellies were still warm (125° F.) those from the right side were dipped in a 115° F. 10% BHA in lard solution. One test was made using a 5.5% BHA dip solution.

[a] Presented before the Thirteenth Annual Meeting of the Institute of Food Technologists, June 22, 1953, Boston, Massachusetts.

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Both sides were then stored at 29° F. for 24 hours, then sliced. The sliced bacon was wrapped and stored at 28° F. and 0° F. in the absence of light.

In evaluating the development of rancidity in the bacon fat an attempt was made to show a correlation between peroxide formation using a modification of Wheeler's method *(8)* and results obtained from a trained taste panel.

Chemical procedure. (a) Extract 0.4 g. of fat from bacon slice with 3 ml. of fat solvent composed of a 3 to 2 mixture of acetic acid and chloroform.

(b) Add 1 ml. of a saturated potassium iodide solution to the extract.

(c) Swirl for 1 minute.

(d) Add 10 ml. of distilled water and titrate with 0.01 *N* sodium thiosulfate.

The results are then expressed as milliequivalents of oxygen per kilogram of fat.

The remainder of the same strips, lean and fat was then cooked and the flavor evaluated by a trained panel. The panel evaluated the samples on a one to 10 scale with 10 representing rancidity and one a normal fresh flavor. Samples were evaluated at weekly intervals and after each evaluation the remainder of the sample package was put back into cold storage. This test method was used in all stability tests.

A sample was taken from each of the treated bellies and analyzed for antioxidant concentration. Determinations were made on raw unfried bacon, fried bacon, and grease resulting from frying. Two methods were used on each sample, a modification of the dipyridyl method (DP) *(9)* and a modification of the dichloroquinonechlorimide (DC) *(10)* method. Since both of these methods were set up to be used on lard and shortening or vitamin analysis, certain modifications were made in sample preparation.

Procedure. (a) Extract 25 g. of bacon in Waring blendor for 3 minutes, using 50 ml. of petroleum ether (Skelly Solve F.).

(b) Centrifuge for three minutes at 1500 R.P.M. and decant extract into 500 ml. Squibb separatory funnel.

(c) Wash residue with three 25 ml. portions of petroleum ether, centrifuge for three minutes at 1500 R.P.M. and add wash to separatory funnel.

(d) Wash extract with three 25 ml. portions of water and discard wash.

(e) Extract petroleum ether with three 25 ml. portions of 72% ethyl alcohol.

(f) Back wash alcoholic extract with 125 ml. of petroleum ether and draw off alcoholic phase.

(g) Extract petroleum ether fraction with two 10 ml. portions of 72% ethyl alcohol and add to previously developed alcoholic phase.

(h) Make to 100 ml. with 72% ethyl alcohol.

(i) Use suitable aliquots for both analytical schemes.

This sampling method was used on raw and cooked bacon. Blending and centrifuging were not needed for the grease analysis. Standard curves using BHA in ethyl alcohol were prepared for the DP and the DC methods for each series of determinations.

In an effort to study the effect of cooking upon the composition of bacon a series of cooking tests were run. Twelve samples of 8- to 10-pound bellies, similar to those used in stability tests, were fried and the resulting grease and cooked bacon were analyzed for fat and moisture content. An analysis of the raw starting material was also made. Care was used in all cooking tests to see that the bacon was cooked to the same degree and under substantially the same conditions.

RESULTS

In the preliminary tests involving antioxidant injection, the HQ and HQ complimented with other antioxidants, showed the best stabilizing effect, followed by PG and BHA in that order. Table 1 shows the results of these observations.

The use of HQ, PG and CA were of academic interest only. HQ is not an approved additive for meat products. Further, it had a detectable flavor in the cooked product and produced a peculiar, unpleasant odor during frying.

PG is not practical in commercial use in this process due to its color producing reactions with iron. Even with utmost care, iron traces came into contact with the PG and produced a purple pickle solution. This produced purple areas in the bacon.

TABLE 1
Keeping quality of bacon with added antioxidants

Antioxidant used	Time to rancidity in days at 28° F.*	% by weight of bacon
Control	35	0.00
Hydroquinone	114	0.039
Hydroquinone and propyl gallate	114	0.039 and 0.016
Hydroquinone and citric acid	114	0.039 and 0.0016
Propyl gallate	85	0.016
Butylated hydroxyanisole	48	0.039

* Average values based upon duplicate treated samples and ten control samples.

CA lowered the pH of the pumping pickle so that the oxides of nitrogen were evolved from the sodium nitrite present and prevented its use in further studies. It is not possible to produce a cured meat product such as bacon without nitrite which gives the characteristic pink color to cured pork. For these reasons BHA was used in all subsequent tests.

In all of the following tests BHA was dissolved in lard and the bacon bellies were dipped in the solutions. This eliminated the homogenization step of BHA with a suitable emulsifier as was encountered when BHA was injected. Table 2 shows the effect of a BHA dip on bacon stability.

TABLE 2
Effect of dipping bacon sides in lard containing butylated hydroxyanisole (BHA)

Percent BHA in lard dip	Time to rancidity in days at 28° F.	
	Test	Control (No BHA)
10.0	53	40
10.0	120	92
10.0	138	113
5.5	117	82

Samples kept at 0° F. had a 10-15% increased keeping time over samples held at 28° F.

There appeared to be no correlation between the results obtained by chemical determination of peroxide values and the results of the taste panel. Some samples that gave a relatively low peroxide value were judged inedible by the panel due to the high degree of rancidity. The average values obtained for all samples are shown in Figure 1.

Therefore, all determinations of keeping time were based upon the panel values rather than the results of chemical analysis.

Moldiness frequently interrupted the holding tests. This was especially true of the treated samples whose holding times were generally in excess of the control samples.

The composition analysis of the samples showed a fat, moisture and lean partitioning in the raw bacon, and the cooked bacon. This is shown in Table 3.

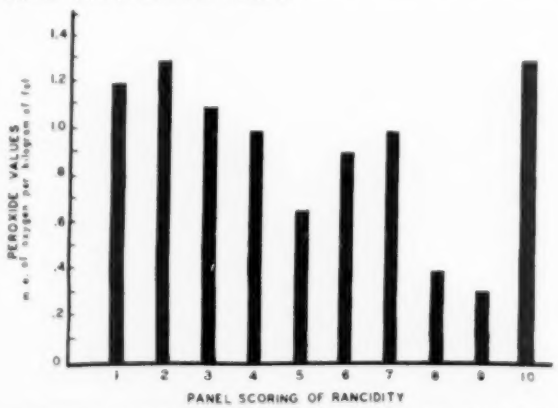

Figure 1. The relationship between chemical and taste panel methods for determination of rancidity in bacon.

These values as based upon raw weight are shown in Table 4.

The analysis of BHA concentration in the initial dipping test using a 10% BHA in lard solution was determined using the DP method as shown in Table 5.

In the second test using a 10% BHA in lard dip both the DP and DC methods were used for BHA determination, as shown in Table 6.

TABLE 3

Comparative composition of raw and cooked bacon

Percent by analysis	Bacon	
	Raw	Cooked
Water	22.3	8.1
Fat	69.3	53.7
Protein	8.4	38.2
	100.0	100.0

TABLE 4

Cooked bacon related to raw weights

	Percent of raw weight
Cooked Bacon	22.0
Moisture	1.8
Fat	11.8
Protein	8.4
Cooking Losses	78.0
Fat	57.5
Moisture	20.5

TABLE 5

Dipyridyl determinations of butylated hydroxyanisole (BHA) in treated bacon [a]

Sample	Percent BHA		
	Raw	Cooked	Grease
1	0.0628	0.0368	0.0684
2	0.0260	0.0184	0.0128
3	0.0140	0.0251	0.0280
4	0.0208	0.0289	0.0308
5	0.0392	0.0268	0.0356
6	0.0220	0.0259	0.0188
7	0.0280	0.0304	0.0460
8	0.0412	0.0252	0.0232
9	0.0280	0.0224	0.0256
10	0.0168	0.0252	0.0248
Average	0.0299	0.0263	0.0314

[a] Bellies were dipped in a 10% BHA lard solution.

TABLE 6

Comparison of dipyridyl (DP) and dichloroquinonechlorimide (DC) methods for butylated hydroxyanisole (BHA) analysis [a]

Sample	Percent BHA					
	Raw		Cooked		Grease	
	DP	DC	DP	DC	DP	DC
1	0.0947	0.0342	0.0570	0.0201	0.1059	0.0373
2	0.0403	0.0142	0.0285	0.0100	0.0198	0.0070
3	0.0217	0.0076	0.0389	0.0137	0.0434	0.0153
4	0.0322	0.0114	0.0448	0.0158	0.0477	0.0168
5	0.0607	0.0214	0.0416	0.0146	0.0552	0.0194
6	0.0341	0.0120	0.0370	0.0130	0.0292	0.0103
7	0.0434	0.0153	0.0477	0.0166	0.0713	0.0251
8	0.0638	0.0224	0.0391	0.0137	0.0360	0.0127
9	0.0434	0.0153	0.0347	0.0122	0.397	0.0140
10	0.0260	0.0092	0.0391	0.0137	0.0384	0.0135
Average	0.0460	0.0163	0.0408	0.0143	0.0487	0.0171

[a] Bellies were dipped in a 10% BHA lard solution.

From Table 6 it is seen that while the DP method gave higher values than the DC method both procedures gave proportional results in BHA distribution in raw bacon, cooked bacon, and the cooked-out fat.

A repeat of this analytical scheme was made on samples dipped in a 5.5% BHA in lard solution. This study shows the same basic results as the 10% BHA dip test, Table 7.

In all of the tests results obtained with DP method were consistently higher than those obtained by the DC method. One reason may be attributed to the specificity of the chlorimide method for BHA, while the DP reagents may react with certain

TABLE 7

Comparison of dipyridyl (DP) and dichloroquinonechlorimide (DC) methods for butylated hydroxyanisole (BHA) analysis [a]

Sample	Percent BHA					
	Raw		Cooked		Grease	
	DP	DC	DP	DC	DP	DC
1	0.0075	0.0026	0.0079	0.0028	0.0270	0.0101
2	0.0174	0.0101	" "	0.0068	0.0303	0.0111
3	0.0202	0.0071	0.0102	0.0036	0.0264	0.0096
4	0.0510	0.0180	0.0326	0.0115	0.0233	0.0088
5	0.0298	0.0105	0.0089	0.0031	0.0329	0.0112
6	0.0223	0.0102	" "	" "	0.0351	0.0134
7	0.0298	0.0105	0.0729	0.0257	0.0260	0.0092
8	0.0198	0.0115	0.0242	0.0092	0.0290	0.0104
9	0.0082	0.0029	0.0057	0.0020	0.0288	0.0099
10	0.0445	0.0157	0.0369	0.0130	0.0262	0.0091
Average	0.0250	0.0099	0.0249	0.0086	0.0279	0.0103

[a] Bellies dipped in a 5.5% BHA lard solution.

phenolic smoke constituents which were not completely removed or certain phenolics inherent in the bacon.

Dipping bellies into BHA in lard solution gave a wide range of concentration in the final product. This may be attributed to the belly size in proportion to weight, or to drip of antioxidant off the belly, which in turn is a function of belly and lard temperature.

SUMMARY AND CONCLUSION

Two methods of antioxidant application to bacon have been described.

Increased bacon shelf life is obtained with addition of fat stabilizers. BHA in bacon gave a protection factor of 1.3 as measured by a trained taste panel.

No correlation was shown between chemical analysis of rancidity and trained taste panel results.

Although the DP and the DC methods of antioxidant determination gave different values for actual concentrations, their results were proportionate to each other in all phases of the analysis. Both tests showed the distribution of the antioxidant in the same pattern.

Acknowledgment

The authors wish to express their appreciation to H. E. Whitmore and A. E. Hoffman of Universal Oil Products Company for BHA samples used in this experimental work.

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Crumb Softness from Soy Fractions[a]

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(Manuscript received June 5, 1953)

The effects of two soy products—(a) Gelsoy, and (b) soybean whey solids—on crumb firmness have been studied in the laboratory. Gelsoy has been used in a single commercial baking trial. Gelsoy (1%) doughs had handling qualities equal to doughs containing 0.5% POEMS, and the bread crumb was resilient in contrast to the crumb of bread containing POEMS. Both Gelsoy and whey solids cause a marked decrease in crumb firmness although not as great as that obtained with 0.5% POEMS. Use of 1% Gelsoy allows an increase in absorption of 1% and requires a small increase in oxidizing agent.

The keeping quality of bread has assumed ever greater importance with increased centralized production and the development of modern merchandizing methods. Cereal chemists have striven to improve the keeping quality of bread ever since scientific methods have been applied to the problems of the milling and baking industries. In recent years, the housewives' willingness to judge bread freshness on the basis of lack of resistance when the loaf is squeezed has led to the use of various crumb-softening agents. These have been reduced in practice to two general types: (a) monoglycerides, and (b) polyoxyethylene monostearates or POEMS as they will be referred to in the rest of this paper. The efficacy of these materials in softening the bread crumb has been well demonstrated by Carson, Marnett, and Selman *(3)*, Edelmann, Cathcart, and Berquist *(4)*, and Skovholt and Dowdle *(5)*.

In addition to the crumb-softening effect, the polyoxyethylene compounds function in the doughs to produce a smoothness and fluidity which leads to better machinability and less punishment of the doughs. The result is more uniform bread and the production of fewer cripples, as well as a softer bread crumb.

Under a contract between the Northern Regional Research Laboratory and Food Technology of Chicago, it was discovered that low levels of a soy flour fraction called "Gelsoy" improved crumb softness. This finding was confirmed and extended in our own baking laboratory along with studies of a similar nature on another fraction called soybean "whey solids."

Because of heightened interest in other softeners since the banning of the polyoxyethylene-type compounds, it seems of interest to present our results for appraisal by the industry. The object of this paper is to present a portion of our data on this use of soy fractions.

EXPERIMENTAL

Materials and methods. The soy fractions used in this study were (a) Gelsoy, first described by Beckel, Belter, and Smith *(1)* and prepared in the Northern Regional Laboratory pilot plant, (b) "Pro-gel," the commercial counterpart of Gelsoy, and (c) spray-dried soybean whey solids. The whey solids were prepared by two methods: by extracting undenatured hexane-extracted soybean flakes with water adjusted with HCl to yield a slurry at pH 4.5, centrifuging and spray-drying the supernatant liquor; by spray-drying the solution which is left from soybean protein isolation as described by Belter, Beckel and Smith *(2)* and Smith and Circle *(6)*.

Commercial softeners used for comparative purposes were "Emulgin,"[c] a polyoxyethylene monostearate-type compound and "Myvatex,"[c] a commercially distilled glyceryl monostearate in 50% admixture with lard.

Our results reported here are primarily those from our experimental baking laboratory, although we have made one commercial trial in a wholesale bakery using Pro-Gel.

The formula used in the laboratory baking tests was as follows: Yeast, 2%; Arkady, 0.5%; salt, 2%; sugar, 3%; shortening, 3%; non-fat dry milk solids, 3%; and water as required—all based upon flour as 100%. The wheat flour used was a commercially milled baker's patent with 0.44% ash and 11.5% protein (14% moisture basis).

The sponge and dough procedure was employed with a 4-hour, 60% sponge, optimum absorption, optimum oxidation and mixing at the dough stage to optimum development as determined by the operator. A 30-minute floor time and 20-minute rest period at 88° F., 85% r.h. were employed. The doughs, scaled to 530 g. were "punched" on a National dough sheeter and sheeted on the same instrument prior to molding by hand.

Doughs were proofed at 99° F., 95% r.h. to ⅜ inch over the top of the pan and baked for 30 minutes at 425° F. in an electrically heated rotary hearth oven with low pressure steam injected during the entire baking period. The loaves were cooled for 1 hour at room temperature, wrapped in waxed paper, and stored in tin-lined drawers overnight. The laboratory was maintained at 78° F. and 55% r.h. at all times.

In the commercial baking test, 1% Gelsoy was introduced into the dough without modification of the formula or procedure other than an equivalent increase in absorption of the dough; the results were compared with those from a control batch containing no softener and with the regular production bread containing 0.5% "Emulgin" (POEMS).

Compressibility of bread crumb was measured with a modified Bloom Gelometer. The values determined are the number of grams of shot required to cause a depression of the crumb to a depth of 4 mm. when a 1-inch diameter plunger and bread slices ½-inch thick are used. All but the 3 slices at each end of the loaf were used to obtain representative results.

RESULTS AND DISCUSSION

Results of laboratory comparisons of Gelsoy and whey solids with POEMS and monoglyceride are shown in Table 1. The data are presented as the differences in Gelometer readings between the control and the bread containing the materials under investigation, and all results are the averages from the values obtained on four to eight loaves of bread. The results for the commercial baking trial are shown in Table I and Figure 1, in which the comparison of bread containing Pro-Gel is made with bread containing POEMS and the control bread. The crumb softness and loaf volumes reported for the commercial trial are the average values obtained from 10 replicate loaves.

[a] Presented at the Thirteenth Annual Meeting of the IFT, Boston, Massachusetts, June 23, 1953.

[b] One of the Laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

[c] The mention of these products does not imply that they are endorsed or recommended by the Department of Agriculture over others of similar nature not mentioned.

TABLE 1

Increases in crumb softness over a control bread calculated from Bloom gelometer values on the breads[a]

Bake number	0.3% POEMS	0.5% POEMS	0.4% Monoglyceride	1% Gelsoy	1.25% Whey Solids	0.4% Monoglyceride plus 1% Gelsoy
211		18.3			10.2[c]	
207		13.4		5.1[d]		
198					3.6	
197					3.8	
196	4.6				7.7	
195	5.5				8.7	
192				3.3		
191		5.2			3.7	
190					12.9	
187				5.0		
187				7.7[e]		
184				7.3[e]		
238			4.3[e]	5.0[e]		5.8[e]

[a] Softness values all obtained on 16-hour old bread.
[c] 1% whey solids.
[d] Semiworks production.
[e] 4% total fat used in all doughs in this series.

An entirely satisfactory evaluation of the laboratory results is not possible because of the wide variations in the data. In our results there was a wide difference in softness between loaves of the same bake for both the controls and the softened loaves. Likewise, the results for softness of commercial bread varies widely in firmness. We believe, nevertheless, the data justify the conclusion that it is possible to obtain about as much crumb softening effect in the laboratory with 1% Gelsoy or

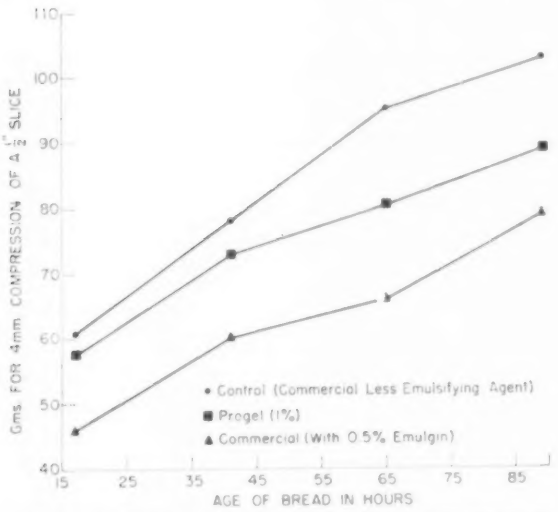
Gms. FOR 4mm COMPRESSION OF A ½" SLICE
AGE OF BREAD IN HOURS
• Control (Commercial Less Emulsifying Agent)
■ Progel (1%)
▲ Commercial (With 0.5% Emulgin)

Figure 1. Compressibilities obtained with Bloom gelometer, using ½-inch slices, on a control bread, bread containing Pro-Gel, and a bread containing 0.5% POEMS from commercial production. Values indicated are averages obtained from 13 slices per loaf, using 4 to 8 loaves.

1.0-1.25% whey solids as can be obtained with 0.3% POEMS. Also, it is indicated from the laboratory data, and the known relationship between POEMS and the monoglycerides that the Gelsoy and whey solids at the 1% level are about equivalent to the monoglycerides at a 0.4% level in obtaining crumb softness. Although only a single comparison was made, it appears that there is little additive effect when the Gelsoy and monoglyceride were used together. The Gelsoy and whey solids appear, however, from data not presented here, to give no decrease in crumb firmness at levels above 1% and in this respect they are not equivalent to the monoglycerides. The decrease in crumb softness attained with 0.5% POEMS appears to be beyond present expectations with either soy fraction. This may be more than compensated for by the maintenance of "spring back" or resiliency, which is about the same in the crumb of bread containing Gelsoy as in fresh bread without an additive. This is in direct contrast to the nearly permanent deformation of bread made with "poly-type" compounds upon application of pressure.

Gelsoy is likely to find favor with production men since it, like POEMS, increases water absorption and has a desirable effect on dough handling properties. In the commercial trial the shop superintendent noted that "the Gelsoy-treated dough passed easily through the divider, had a slight flow in intermediate proof as a well-developed dough should have, and at the molder it sheeted with exceptional ease, was dry, and elastic." The use of 1% Gelsoy was, in this trial, also accompanied by an increase of 1% in the water absorption of the dough.

The laboratory results with the use of whey solids, at 1.0 to 1.25% based on the wheat flour, indicate a softening effect which is equivalent to 1% Gelsoy or to 0.5% monoglycerides. However, the results with whey solids in the commercial trial were unsatisfactory due to improper oxidation level and the resultant low volume compact bread. The addition of 1% whey solids did not increase dough absorption and yielded doughs with signs of tackiness. This tendency was overcome in laboratory work by use of suitable quantities of oxidizing agent. We did not, however, have sufficient material to determine oxidation requirements for either Gelsoy or the whey solids in commercial practice and the lack of proper oxidation is reflected in the loaf volume data shown in Table 2. This is especially true for the whey

TABLE 2

Loaf volumes for 1- and 2-day old commercially baked bread

Formula	Loaf volume (ml.)	
	1-day old bread	2-day old bread
Control	2,438	2,523
0.5% poly-type emulsifier	2,598	2,636
1% Pro-Gel	2,530	2,560

solids. It is quite probable that, based on laboratory experience, the proper oxidation of the doughs containing whey solids and Gelsoy would have increased the loaf volumes of the bread to values almost equal to the volumes obtained with loaves containing the poly-type softener. Larger volumes in the breads containing the soy fractions would have yielded more favorable softness values. Further evaluation of Gelsoy should be performed at the commercial level under wholesale bakery conditions and not in the laboratory.

The whey solids are of special interest since they are the unrecovered portion of the soybean meal in the isolation of soybean protein and represent a serious waste disposal problem. The raw material costs for whey solids would be very low for protein processors,

and their recovery would be a benefit to the processor as well as to the public.

The chief compositional difference between Gelsoy and whey solids is in protein content. Whereas, the Gelsoy contains about 8.8% nitrogen, the whey solids analyze about 2.5% nitrogen on a moisture-free basis and only about one-half of the whey nitrogen is protein nitrogen. This relationship suggests the possibility that the bread softening effect of whey solids may be due to a nonprotein component. Work on the whey solid is being continued.

With sufficient material to establish optimum operating conditions, it is very likely that at least one of these soy products may prove to be of value to the baker in obtaining desirable dough handling characteristics and decreased crumb firmness with the advantage over the PODMS of resiliency in the bread crumb.

Acknowledgment

The authors wish to acknowledge the cooperation and assistance of the Purity Baking Company of Peoria, Illinois, especially Mr. Joseph Dergins, shop superintendent, in making the commercial run of Pro-Gel possible. The Pro-Gel used in these studies was supplied from the pilot plant of Allied Mills, Inc., Peoria, Illinois, under a collaborative agreement with the Northern Laboratory.

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The Volatile Content of Air in Commercial Apple Storages[a]

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(Manuscript submitted June 15, 1953)

It is shown that the atmospheres of two large commercial cold storages, analyzed at regular intervals to determine their content of ethylene and other volatiles, remained relatively low in ethylene concentration (.10 mg. to .15 mg. per cu. ft.) and in other volatiles (less than .1 to more than .15 ml. 1N cerric sulfate equivalent per cu. ft.).

Keen competition in fruit marketing, with emphasis on fine quality, demands additional refinements in all phases of apple production and handling. In order to retain good quality in stored fruit optimum conditions of maturity, temperature and humidity are required. In recent years further improvement in storage technique has been sought through the removal from storage atmospheres of naturally evolved fruit gases thought to be detrimental to keeping life of the fruit. Numerous "air purification" experiments have been conducted using filter mediums such as activated carbon to adsorb volatiles from the storage atmosphere *(5)*. Some investigators have reported considerable success in extending keeping life of apples, but other workers have found no benefit from the use of activated carbon filters.

REVIEW OF LITERATURE

For many years scientists have been aware of the stimulating effect of ripe fruit on unripe fruit. Early in the 20th century bananas, in shipments from Jamaica to the United States, were observed to ripen rapidly when mixed with oranges or other lots of ripe bananas. Denny *(2)* showed that ethylene was effective in ripening and colouring oranges. Elmer *(3)* demonstrated that gases from ripe apples inhibited sprouting of potatoes while Huelin *(11)* showed that similar effects on sprouting potatoes could be obtained by both pure ethylene and gases from ripe apples. Kidd and West *(12)* in 1933 produced immediate increase in respiration rate of preclimacteric apples by exposing them to vapours of ripe apples. It was Gane *(6)* in 1934 who positively identified ethylene by chemical tests as the active stimulatory substances produced by apples.

In addition to stimulating ripening, naturally evolved fruit gases are thought to contribute to storage disorders such as scald in apples and pears. Although acetaldehyde is thought to cause scald, other substances such as vapours of ethyl acetate, amyl acetate, or methyl butyrate have been shown to produce scald artificially *(1)*.

It is therefore apparent that volatile accumulations are capable of impairing keeping quality of fruit under certain conditions. Removal of fruit volatiles from storages by means of activated carbon air purification has been recommended by some authorities as a means of prolonging keeping life of apples.

Among the first reports on air purification to arouse interest were those of Smock *(13)* in 1944. He suggested brominated activated carbon as a satisfactory filter for removing fruit volatiles. Various reports by Smock and Southwick in the following years indicated considerable success in scald control plus 2 to 4 weeks extension in storage life of apples as a result of activated carbon air purification. Their bulletin *(14)* in 1948 reviews numerous air purification tests on both an experimental and commercial scale in which good results were obtained in scald control, odour removal and extension of storage life.

Benefits from carbon air purification of apples have also been reported in investigations by Van Doren *(15, 16)* who showed 1 to 2 months extension of storage life.

There are, however, conflicting reports concerning the merits of air purification, conspicuously those of Gerhardt *(7, 8)* in Wenatchee, Washington, Fidler *(4)* in England and Fisher

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and Porritt *(5)* in British Columbia who found no decrease in the rate of softening of apples stored with activated coconut shell carbon air purification. Furthermore, these investigators found oiled wraps superior to air purification in controlling scald.

Manufacturers were quick to enter the field of air purification. They now offer specialized filter equipment which is claimed to lengthen storage life of apples, reduce or completely eliminate scald, and keep apples free from storage flavours.

In view of the benefits claimed for air purification, the costs are not high. Amortizing cost of equipment over a 10-year period and adding interest, depreciation and electrical energy consumption, brings the annual per box cost to only 1.2 cents. However, if benefits from air purification are no greater than those found in England, Washington, or at the Summerland Station, air purification equipment would appear to be an unwarranted expense that could cost the fruit industry of the Interior of British Columbia as much as $75,000 yearly.

In order to determine the need for air purification in commercial apple storages it was felt that actual concentrations of fruit volatiles existing during the storage season should be known. This information then should be considered in relation to the minimum concentration of volatiles which can stimulate fruit at cold storage temperatures.

EXPERIMENTAL

During the 1952-53 storage season the atmospheres of 2 large commercial cold storages were analysed at regular intervals to determine fruit volatile content. Ethylene and volatiles other than ethylene were determined according to a method developed by Gross of Cornell University. During the latter half of September, October, and November analyses were made every 2 or 3 days in the Occidental Fruit Co. Storage and once each week in the Summerland Co-operative Growers' storage. During December analyses were made weekly, and in January and February analyses were carried out twice monthly in each storage.

The portion of the Occidental Fruit Co. in West Summerland used in the tests has a capacity of 70,000 boxes; brine spray refrigeration is employed with central air distribution. The part of the Summerland Co-operative Growers plant in which the experiment was carried out has a capacity of 140,000 boxes with a central air distribution system and water defrost refrigeration.

Samples of storage air were taken for analysis from return air in the fan rooms. As indicated in Table 1, temperatures approximated 32° F. The portable sampling apparatus consisted of a Truog tower containing concentrated sulphuric acid for absorption of volatiles except ethylene, a second Truog tower containing mercuric perchlorate for ethylene absorption, a flow meter, a wet test meter for accurate recording of sample volume, and a portable vacuum pump. Each sample measuring 15 to 30 cubic feet was drawn through the absorption apparatus at the rate of 20-30 litres per hour.

RESULTS

Results of analyses presented in Table 1 and depicted graphically in Figure 1 reveal that concentrations of both ethylene and other volatiles remained relatively low in both storages. The graph for the Occidental during the period September 15 to November 30 was plotted from weekly averages of 3 to 4 analyses but all remaining points represent single analyses. The graph depicting volatile levels in the Summerland Co-operative was plotted from single analyses throughout the season. Ethylene concentration was generally .10-.15 mg./cu. ft. while other volatiles varied from less than .1 to somewhat more than .15 ml. .1N cerric sulfate equivalent. A comparison of these data with other reports shows volatile levels in the two Summerland storages to be one-half to one-quarter the concentration reported for commercial storages in Oregon *(10)* and in Washington *(8)*.

The work done in Washington indicates that a general increase occurs in the volatile concentration in storage as the season advances. This might be expected since the ripening of fruit increases the volatile output. On the other hand the amount of fruit in storage is reduced as the season advances. In the Summerland plants the volatile concentrations remained at about the same general level except for occasional anomalous fluctuations.

From these results it is apparent that a very considerable loss of volatiles occurs by diffusion, air exchange through doors and conveyor ports, and possibly by removal in defrost water. In

TABLE 1

Progressive seasonal changes in levels of ethylene and other volatiles in two commercial apple storage warehouses

Date sample taken	Volume of sample	Temp. of storage	Volatiles recovered per cu. ft. air	
			Ethylene	Other volatiles
	cu. ft.	*° F.*	*mg.*	*ml. .1N sulfatocerate equivalent*
Occidental Fruit Company				
September				
18	36.0	35.0	.033	.057
19-21	72.0	35.0	.089	.060
21-23	118.0	34.0	.081	.089
24-26	39.0	34.5	.260	.080
29	48.0	34.0	.192	.078
30	28.0	35.0	.135	.298
October				
3	22.0		.225	.080
4	24.6	33.0	.315	.056
6	10.4	35.0	.222	.047
7	21.6	34.0	.149	.063
8	24.0		.155	.080
11	25.5	33.0	.159	.064
15	18.2	32.0	.127	.084
17	21.2		.083	.104
18	12.6	32.0		.061
20	36.2	32.0		.085
21	21.6	34.0	.091	.117
22	24.8	32.0	.096	.105
24	21.7	32.5	.190	.144
25	17.8	31.5	.095	.250
27	39.0	32.5	.136	.101
28	29.1	32.0	.076	.120
29	20.4	31.0	.091	.130
31	23.1	32.0	.101	.074
November				
4	30.5	32.0	.098	.088
5	14.7	31.5	.098	.155
7	15.4	31.0	.312	.167
8	17.8	31.0	.025	.037
10	27.3	31.0	.091	.187
12	15.9	31.0	.176	.077
14	15.1	30.0	.093	.095
17	44.2	32.0	.091	.088
18	15.9	32.0	.10-	.148
19	17.8	31.0	.102	.096
21	6.8	31.0	.084	.070
24	23.4	32.0	.136	.093
26	32.7	32.0	.122	.383
December				
1	44.7	30.0	.077	17.2
9	17.2	31.0	.118	.117
15	24.6	31.0	.174	.103
January				
8	33.2	30.5	.157	.108
22	26.4	31.0	.156	.136
25	60.0	31.0	.109	.177
February				
6	32.9	31.0	.097	1.29
28	22.3	30.5	.087	.092
Summerland Co-op Growers				
October				
2	25.0	31.0	.194	.120
16	18.3	31.5	.098	.126
23	50.7	35.0	.064	.119
30	15.3	32.0	.065	.086
November				
6	15.6	32.0	.061	.151
13	19.9	31.0	.099	.166
20	13.6	32.0	.101	.502
28	15.5	30.0	.086	
December				
3	38.9	31.0	.065	.061
12	24.1	31.0	.073	.103
18	24.9	30.5	.131	.102
January				
9	29.8	31.0	.103	.163
February				
4	30.6	30.5	.129	.106
14	24.5	31.0	.103	.103
March				
9	38.8	30.5	.060	.128

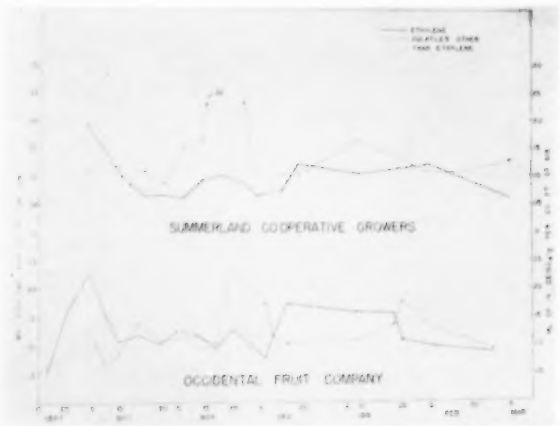

Figure 1. Seasonal changes in levels of ethylene and other volatiles in two commercial apple storage warehouses.

a loaded commercial apple storage there is approximately 2.5 cu. ft. of free air space per packed box. Therefore if it is assumed that 3 ml. (3.75 mg.) of ethylene are produced by one bushel of apples in 24 hours as reported by Hansen (9) this would amount to a daily output of about 1.2 mg. of ethylene per cu. ft. of free air space in a loaded storage. This is many times the concentration found at any time in the two storages examined.

DISCUSSION

At present there is insufficient knowledge to predict the effects of air purification for apples with activated carbon. In considering how air purification might or might not improve the keeping life of fruit the following factors must be taken into account.

(a) Respiration and ripening of preclimacteric apples may be stimulated by ethylene. This phenomenon has been observed generally at temperatures considerably in excess of 32° F. and with relatively high ethylene concentrations. The minimum concentrations of ethylene and the lowest temperatures at which stimulation can be produced has not been determined.

(b) Of the volatile substances produced by fruit, only ethylene is known to stimulate ripening and only in preclimacteric fruit. The amount of fruit entering storage in the preclimacteric as opposed to the post-climacteric stage has not been determined. Furthermore, negligible quantities of ethylene are adsorbed by plain activated carbon.

(c) Acetaldehyde produced by fruit and associated with scald may be adsorbed fairly efficiently with activated carbon.

(d) Isolated apples exhibit a respiratory climacteric presumably as a result of auto-stimulation. Volatiles from one fruit may stimulate neighbouring fruits. Consequently in a bulk sample such as a bushel box, the onset of the climacteric will be determined by the physiological age of the ripest individual capable of causing stimulation. Air purification to be effective, therefore, would require that volatiles be kept to a certain minimum concentration in packed boxes in all parts of the storage.

Limited tests at the Summerland Station on apples in packed boxes well exposed to air movement showed volatile levels at the centre of the boxes at least twice as high as that found in the surrounding storage atmosphere. Furthermore, respiratory studies on commercial samples of fruit during the past season indicate that as much as 50% of the apples may be post-climacteric upon arrival at the packing house.

All these factors would indicate that the role of air purification in fruit storage would be difficult to define taking into account volatile levels, temperatures, and maturity of fruit entering the warehouse.

SUMMARY

Throughout the 1952-53 season, September 15 to March 1, the atmospheres of 2 large commercial cold storages were analysed at regular intervals to determine content of ethylene and volatiles other than ethylene.

Analyses of air samples, which were taken from the central fan rooms of the storages, were carried out according to the method of Gross of Cornell University. Each sample measured 15-30 cu. ft., was metered through the absorption apparatus at the rate of 20-30 litres per hour and recorded on a Wet Test gas meter.

Comparison of analyses with those from similar tests in Washington and Oregon indicate that both ethylene and other volatiles remained relatively low in both storages throughout the season. Ethylene concentration was generally .10-.15 mg./cu. ft. of storage air and other volatiles varied from less than .1 to somewhat more than .15 ml. .1N cerric sulfate equivalent per cu. ft. of air.

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Fat Injection of Beef Animal Parts[a]

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(Manuscript received May 20, 1953)

Among the attributes of high quality beef muscle is a characteristic known as marbling which is generally associated with tenderness and flavor. Currently these effects are achieved through a high caloric intake in feedlots. This process is inefficient and results in undesired fat depots outside the muscular tissue. This paper presents an improved technique for the induction of marbling by mechanically introducing fat into the vascular systems of beef. Results are described for the injection of modified whole carcasses, rounds and loins. Owing largely to vascular damage caused by standard meat packing house practices, uniform results were not obtained with whole carcasses and loins. As evaluated on the visual criteria of overall fat distribution and marbling best results are achieved with rounds. These studies failed to reveal a marked improvement in flavor or tenderness following injection.

Efficient production of well-marbled beef muscle, with the generally associated qualities of tenderness and flavor, is of vital importance to the meat industry and the American consumer. Currently the production of well-marbled beef muscle is achieved by grass feeding young cattle for a time and then deliberately overfeeding in specialized areas called feedlots to produce a desirable "finish." This method of producing marbled beef is inefficient. Mere maintenance of metabolic processes requires a large amount of feed. Moreover, a desirable degree of marbling can be attained only after excessive and unnecessary layers of fat are deposited in areas of scant muscular tissue. Large amounts of time, labor and capital are tied up in the finishing process. A rapid and simple process of marbling meat is needed.

A literature search disclosed pertinent work by Schotte *(1)*. He claimed that lower quality beef is upgraded and made more tender and flavorful by vascular distribution of melted fat in animal carcasses. His process involves saline injection, followed by melted fat, into the vascular system of a stunned, unbled animal. Entry through the left ventricle is proposed. Egress of blood, saline and melted fat is through the right ventricle. Various ligations are proposed to minimize fat leakage into body organs and cavities. It is claimed that a type of marbling results which resembles that produced by overfeeding. Muscle tissue is highly vascularized and each muscle cell or fiber is surrounded by a network of capillaries. Injection should result in fat penetration into the perimysial and endomysial spaces of the muscle bundles and thereby extensive and direct contact between fat and protein should be achieved.

The mechanism of fat deposition and associated phenomena due to overfeeding are not thoroughly understood but some facts are known *(2)*. Marbling due to overfeeding occurs to a degree in all areas penetrated by the vascular system. However, it is more noticeable between the muscle fiber bundles, the perimysial area, rather than between individual muscle fibers within the smallest bundle, the endomysial area. Tenderness is often associated with high fat content, particularly when the fat is contiguous with the muscle fiber bundles. In view of the theoretical similarity between natural fat deposition and that obtained by injection, it is possible that this similarity might include tenderness and associated phenomena.

This paper reports the development of an improved vascular injection technique using melted fat and the evaluation of its effects on meat quality. Consideration is given to whole carcass injection, with or without evisceration, and to injection of relatively small parts of the carcass. The term, whole carcass, as used here refers to an eviscerated carcass minus forequarter, plate and flank. The small parts are beef rounds and loins.

MATERIALS AND METHODS

Figure 1 shows a portion of the injection equipment consisting of a 50-gallon jacketed tank of sanitary design with stirrer, an advancing cavity positive action pump, pressure regulator and tubing. Assorted stainless steel cannulae were used, from ¼" to $^{3}/_{32}$" O.D. The tank and pump are mounted on a wheeled platform. To control the amount of fat injected, whole carcasses were hung by their hocks on a rail scale; smaller parts were injected on a platform balance. Oleo oil or oleo stock were used for injection.

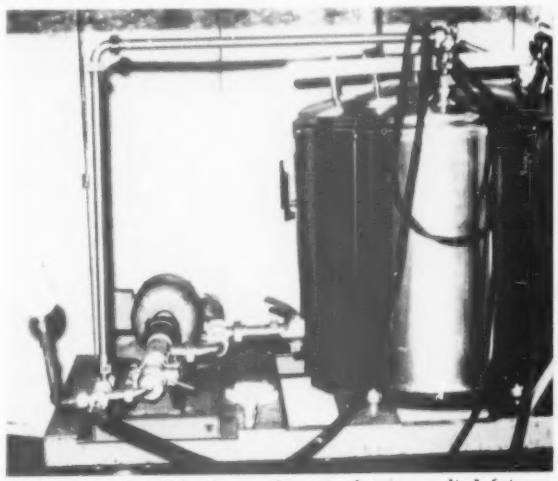

Figure 1. Fat injection equipment, showing melted fat reservoir, pump, pressure hose and regulator and return line.

Melted fat was pumped at the selected temperature and pressure via a hose and a cannula into the desired vascular orifice. The positive action pump is capable of pressures from 0 to 30 p.s.i. Pressures employed for injection varied over a considerable range; in general, maximum pressures compatible with the continued integrity of the vascular system are used. Various methods of killing, flaying, eviscerating, and subsequent dissection were investigated. Initial injection attempts were made on freshly killed, uneviscerated animals. Sites of injection included (a) the heart, (b) the carotoid arteries and (c) the aorta for posterior injection and the brachiocephalic trunk for anterior injection. Injection points are shown in Figure 2. As

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the posterior injection showed the most promise, this possibility was investigated in detail. The use of multiple injection sites on whole carcasses was also examined. The experimental program included injection of carcasses at approximately body temperature, after chilling to 35° to 40° F. and after raising the temperature of chilled carcasses to about 60° F. Based on anatomical considerations and the fat distribution in choice

BEEF CARCASS INJECTION SITES

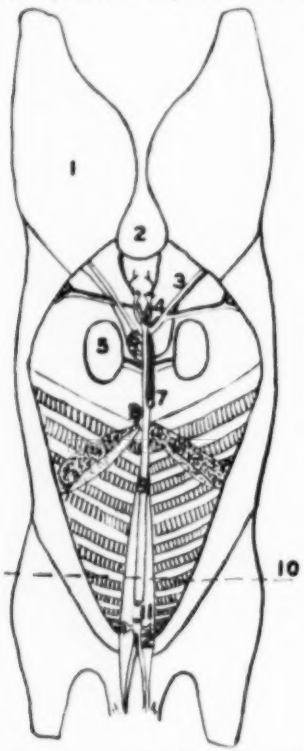

Figure 2. Beef carcass showing sites for injection of melted fats.

1 Thigh	7 Posterior Vena Cava
2 Perineal Region	8 Ileo-Caeco-Colic A.
3 External Iliac A.	9 Aorta
4 Internal Iliac A.	10 Separate Between Ribs 5 & 6
5 Kidney	11 Injection Sites
6 Posterior Mesenteric A.	12 Brachiocephalic Trunk

beef a formula was devised for determining the optimum amounts of added fat for each injected area of individual animals. This formula was tested and corrected by actual injections.

Each injection that appeared to merit further investigation was evaluated by freezing the test meat, cutting it into sections one to 2 inches thick and visually examining the pattern of fat distribution.

The paired comparison taste preference technique *(3)* was used to determine the preference for steaks prepared from injected and noninjected meat. Samples ⅞ in. in diameter and about ¾ in. in thickness were prepared by broiling for 10 minutes on each side at a distance of 3 inches from a gas flame. In each test run 40 observers were given 2 samples of steak. Each observer was asked to comment on the samples and after the second sample to state a preference. A minimum time interval of 30 seconds was maintained between samples. Samples were presented in random order.

A rank order visual preference study *(3)* was made to determine the relative rank of 3 types of steaks, U. S. Choice, Utility, and Utility with 13% injected fat. In this study the samples were placed side by side upon a table. A 2½ in. by 2½ in. window was cut from a plain sheet of white bond paper and placed directly over each sample. In each test the position of the sample was changed periodically so that each sample appeared in each position an equal number of times during the entire study. Twenty observers were used. They were asked to rank the samples in order of visual preference. Weighed scores were determined. For scoring 3 points were assigned for first place, 2 for second and one for third. The weighed score for a sample represents the total obtained after multiplying the first, second and third choice judgments by their respective values.

RESULTS AND DISCUSSION

Injecting whole carcasses. The injection of unevisceratedanimals was accompanied by certain inherent difficulties. Intestinal wall capillaries rupture and large quantities of fat were lost. Further it was necessary to ligate the coeliac as well as the anterior and posterior mesenteric arteries which lead to the intestine and viscera; this process is time consuming. Therefore, no further injection of uneviscerated animals was attempted.

Attempts to inject fat anteriorly through the aorta were particularly unfruitful. While Kosher cutting at right angles to the jugular vein minimizes sticking damage, leakage due to vascular mutilation is not fully amenable to ligation. Oil follows the cut large arteries. Therefore, in subsequent tests the forequarter was removed. In order to conform to the maximum area served by the aorta the forequarters were removed between the fifth and sixth ribs as illustrated in Figure 3.

The posterior injection technique showed more promise; however, examination of sections of test meat

"WHOLE CARCASS" FOR INJECTION PURPOSES

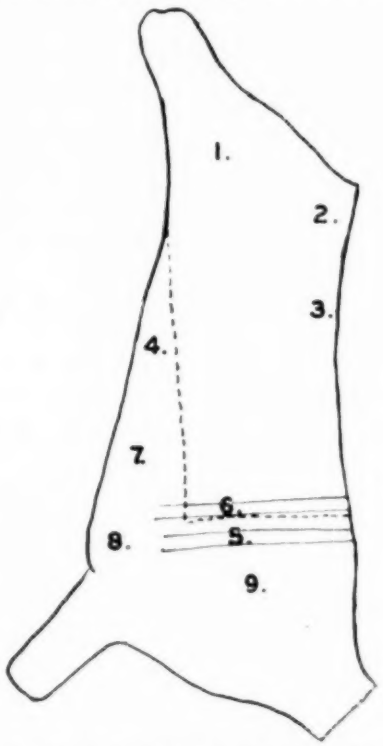

Figure 3. Carcass cut along dotted line to prepare for fat injection of posterior.

1. Round	4. Flank	7. Plate
2. Rump	5. 5th Rib	8. Brisket
3. Loin	6. 6th Rib	9. Chuck

revealed that small amounts of fat penetrated the plate and flank areas. Therefore, these tissues were removed before injection.

Single site aorta injection resulted in poor distribution. Experiments with multiple injection sites were made on a whole carcass and a 3-site procedure was selected. This follows the natural divisions of the vascular system. Experimentation indicated an improved fat distribution.

The optimum method of injecting, then, is as follows: Eviscerate, leaving a long aorta and as few nicks and slashes as possible. Cut off the forequarters at the junction of the fifth and sixth ribs and remove the plate and flank. Inject the carcass (hanging by the hocks) at three sites.

The first site is prepared by tying off the aorta before it forms the external iliac arteries and these latter are clamped. A single puncture is made into the aorta just posterior to the tie. As illustrated in Figure 4, oil is injected into both internal iliacs simultaneously to fill the sacral area. For the second site the clamps are removed from the external iliac arteries and placed on the internal iliac arteries. Injection is then made of the rounds via the external iliacs. The third site is the anterior opening of the aorta into which the cannula is inserted and tied. Melted fat is then injected into the loin area. During injection a considerable amount of ligation is required to minimize fat losses and maintain even fat distribution. At the conclusion of the injection the carcass is chilled and split.

Figure 4. Injection of melted fat into beef internal iliacs via the aorta with external iliacs shown ligated.

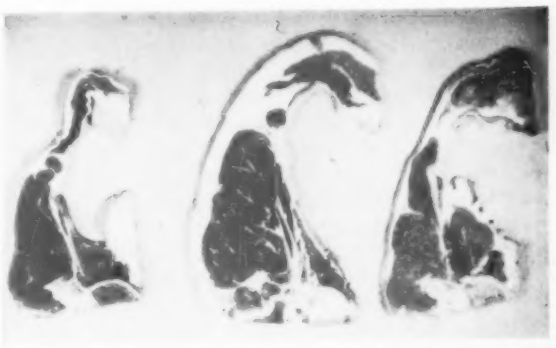

Figure 5. Appearance of steak from injected steer. Left, uninjected steak from utility grade, center, steak from U. S. choice and right, injected steak from utility grade.

Experimentation established that the weight of melted fat added in this sacral region or the area served by the first injection site should be approximately 0.7% of the weight of the entire eviscerated carcass. In the area served by the second injection site, or the rounds, this figure should be 4.0% and in the loin area, served by the third injection site, the figure should be 0.8%. This results in an optimum appearance of marbling. Under these conditions the meat contains by analysis about 15% added fat. Some typical data are shown in Table 1.

Excellently marbled loin steaks and round steaks are obtained from beef carcass injected in the recommended manner. Figure 5 compares an injected steak from a U. S. Utility grade steer with an uninjected steak from a similar steer. Included for comparative purposes is a well-marbled U. S. Choice grade steak. At the recommended level of injection changes in conformation are not great; however, a distinct marbling is noted. His-

TABLE 1
Fat distribution of injected beef carcasses

Sample number	Type[a]	Grade[b]	Dressed carcass weight	Modified carcass weight	Gain	Gain	Percent fat by analysis					
							Right round[c]	Left round	Center loin	Anterior loin	Right sacral	Left sacral
			lbs.	lbs.	lbs.	%						
1	H	C	320	150	24	16.0	25.9	17.9	13.2	14.1	—	—
2	H	U	294	138	16	11.5	3.5	5.6	41.0	—	—	—
3	H	U	273	128	19	14.8	10.1	3.3	29.0	16.2	—	—
4	H	C	337	158	24	15.1	14.6	12.2	19.8	21.0	—	—
5	H	U	332	156	22	14.1	8.6	11.4	16.6	11.6	—	—
6	S	U	350	175	23	13.1	14.3	4.5	21.9	5.0	—	—
7	S	U	326	163	27	16.5	13.6	12.2	16.3	7.8	—	—
8	S	C	406	254	26	10.2	15.0	17.4	18.7	15.7	—	—
9	S	C	356	—	21	—	18.7	21.0	10.6	—	2.1	18.1
10	S	U	325	—	18	—	17.5	14.1	8.2	—	4.4	11.7
11	S	U	351	—	27	—	10.5	26.1	10.2	—	28.0	6.3
12	S	G	470	—	16	—	11.1	5.0	11.9	—	16.4	17.1
13	S	C	265	—	20	—	15.0	24.5	29.9	—	38.7	10.6
14	S	U	316	—	22	—	14.5	16.5	20.3	—	8.3	20.0
15	S	C	278	—	29	—	22.8	33.9	24.3	—	39.2	40.9
16	S	U	277	—	35	—	18.6	18.2	25.6	—	19.5	13.5
17	S	C	384	—	22	—	18.7	14.4	25.9	—	4.4	4.6
18	S	G	464	—	24	—	13.3	12.6	16.1	—	17.7	13.5

[a] H indicates heifers, S indicates steers.
[b] U. S. Grades Commercial, Utility and Good are indicated by C, U and G, respectively.
[c] Ten non-injected U. S. Utility Grade rounds averaged 3.5% fat by analyses.

tological slides made from these areas show that the fat has completely penetrated the vascular system. As seen in Figures 6 and 7 fat has actually entered the endomysial spaces between the muscle fibers themselves.

Results of paired comparison preference studies made on injected and non-injected round and butt steak are shown in Table 2.

Although injected round steak appears to be preferred to non-injected round steak, the data are not statistically significant. Non-injected butt steak is preferred significantly when compared with injected butt steak. It is difficult to fully explain this last observation, but it is believed that as the percentage of high melting oleostearin increases above 15%, an excessive coating effect is noted on the roof of the mouth.

Results of the rank order visual study made to determine the effect of varying percentages of injected fat on consumer preference are found in Table 3. It is noted that the U. S. Choice grade steak is preferred visually when compared with U. S. Utility steak, either injected with 13% fat or non-injected. When the added fat content is in excess of 15% a veal-like pallor results. Visual studies show that such pallor is not desirable.

Figure 6. Longisection of fat injected beef muscle. Fat stained with Sudan IV. Note how injected capillaries follow laminae between muscle bundles and fibers.

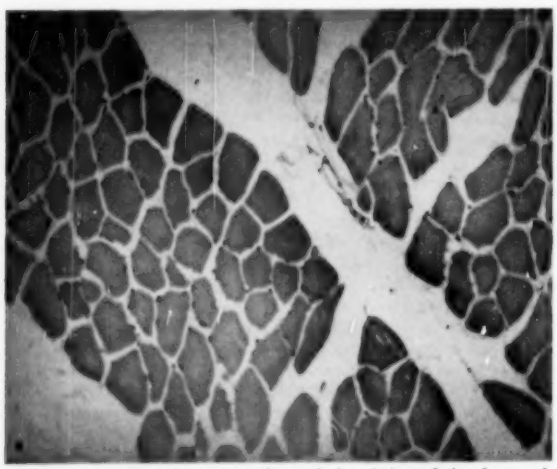

Figure 7. Transverse section of fat injected beef muscle showing fat stained with osmic acid. The black areas are cross sections through fat engorged capillaries.

TABLE 2

Paired comparison taste preference study of injected meat

Sample identification	Observers selecting sample	Standard error	Significance
	%		
Injected Round (14% Oleostearin) Versus	55.0	6.6	Insignificant
Non-injected Round	45.0		
Non-injected Butt Versus	67.5	2.2	Significant
Injected Butt (18% Oleostearin)	32.5		

TABLE 3

Rand order visual study of injected meat

Sample identification	First	Second	Third	Weighed score
U. S. Choice Steak	14	4	2	52
U. S. Utility Steak with 13% Injected Fat	4	6	10	34
U. S. Utility Steak	2	10	8	34

Complete, uniform, and reproducible distribution of fat is difficult to obtain. This is supported by the analytical data in Table 1 and by many visual examinations of transverse frozen sections of injected carcasses. One of the major difficulties to be surmounted is control of fat volume injected, particularly when the amount is small, as in the loin area where it averages about 4 pounds. This difficulty is accentuated by delayed drainage both from the meat surface and from the large blood vessels after removal of the cannula and forceps.

Most difficulty is encountered in controlling fat distribution. The increase in weight of the material undergoing injection includes not only the injected fat but superficial fat due to leakage and that which does not drain from the major blood vessels. Surface fat and the fat trapped in large blood vessels represent a constant and relatively minor part of the fat injected. For achieving satisfactory distribution of fat to muscle tissue temperatures of both the injection oil and meat are critical. Injection of chilled carcasses is not feasible owing to vascular plugging with solidified oil and adherence of collapsed artery walls. If the injection oil temperature falls to within 10° F. of its melting point and if the meat periphery cools to below 60° F., incomplete penetration is observed on transverse sectioning of such meat. This is especially noticeable in rounds, and is characterized by an unsightly margin of dark, uninjected meat.

Injection pressure is critical, especially at lower ranges. Although 4 to 5 pounds should be sufficient, injection anomalies traceable to insufficient pressure appeared below 10 pounds. Twenty to 25 p.s.i. pressure has been selected as giving the quickest, most reproducible results.

Tests were performed in which the position of the carcass was varied, in an attempt to facilitate fat distribution. When carcasses are hanging by the ribs, there is a tendency for rounds to receive excessive amounts of fat; when hanging by the hocks, the position that was finally adopted, a more uniform fat distribution results.

Mutilations are a frequent cause of uneven fat dis-

MUSCLES AND BLOOD SUPPLY OF LUMBAR REGION ("T"-BONE)

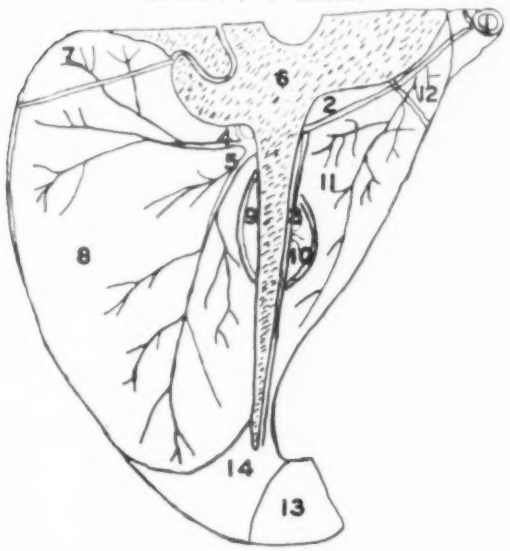

Figure 8. Muscles and blood supply of lumbar region (T-bone steaks).

1 Aorta	7 Multifidus Dorsi M.
2 Lumbar A.	8 Longissimus Dorsi M.
3 Ventral Branch of Lumbar A.	9 Intertransversales Lumborum M.
4 Spinal Branch of Lumbar A.	10 Quadratus Lumborum M.
5 Dorsal Branch of Lumbar A.	11 Psoas Major M.
6 Body of Lumbar Vertebra	12 Psoas Minor M.
	13 Abdominal M.
	14 Fat

tribution. Mutilations occur during evisceration and usually involve the aorta and iliac arteries. This situation is aggravated in the pubic region, by the spreading action of travellers on overhead rails. Further, the aorta is frequently cut posterior to the sixth rib; this results in a portion of the loin remaining uninjected. It is difficult to recognize vascular damage before pumping is initiated.

Injecting carcass parts. The injection system has been applied to beef loins and beef rounds. Attempts to inject unsplit cold loins by way of the aorta resulted in uneven fat distribution. Injection into the lumbar arteries, as shown in Figure 8, is slow, awkward and does not improve the results. When chilled loins are warmed to 60° F. through use of the Tenderay process *(1)* before injection unsatisfactory fat distribution still results.

By far the best and most reproducible results have been obtained with Tenderayed rounds (Figure 9) with rump and shank attached. Injections are made through the femoral and deep femoral arteries. The round is placed on a scale platform so that the cut surface faces the operator. The 2 artery ends are near the center of the cut surface as shown in Figure 10. Pressures up to 30 p.s.i. and oil temperatures up to 145° F. have been used. Weight gains of 10% to 15% produce optimum marbling. The femoral artery is injected first and receives two-thirds of the total injection. The injected round is allowed to drain briefly and then sent to the cooler (40° F.).

Characteristics of meat from injected rounds are quite similar to those of whole carcasses. Well-marbled steaks and roasts are produced and at the proper fat levels the resultant marbling simulates that found in choice loin steaks. Control of volume injected and of fat distribution, while presenting some problems, is substantially more satisfactory than whole carcass injection. Rounds are uniquely adapted to the injection process. With slight modification of packing house procedure, rounds can be removed from beef carcasses, preferably after chilling, in order to minimize muscular retraction. Nominal care must be exercised in eviscerating and handling in order to insure integrity of the vascular system. Adequate warming of the chilled round can be easily achieved by the Tenderay process.

SUMMARY AND CONCLUSIONS

A rapid method of simulating natural marbling in trimmed beef carcasses, beef rounds and loins has been described.

Little success has been attained with beef loins. Although satisfactory results have been observed with carcasses, techniques have not been developed to insure consistant results. Satisfactory marbling can be consistantly achieved by the injection of beef rounds. Beef

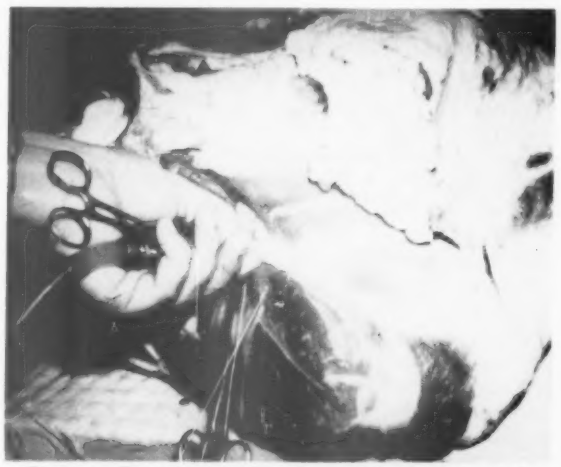

Figure 9. Fat injection of beef round via femoral and deep femoral arteries.

CROSS SECTION OF R & S ROUND

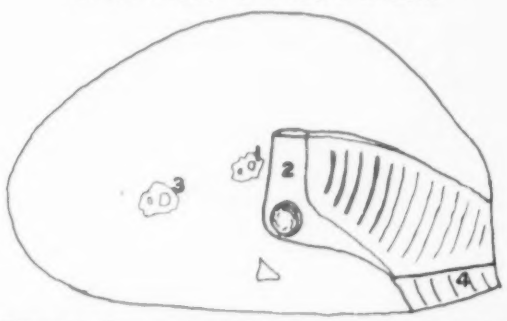

Figure 10. Cross section of beef round showing femoral and deep femoral arteries and veins.

1 Deep Femoral A. & V.	3 Femoral A & V.
2 Pelvic Bones	4 Vertebrae of Tail

rounds are easily prepared for injection under current packing house conditions.

Existing techniques for fat injection present varying degrees of difficulty with respect to controlling the amount and distribution of fat.

Vascularly injected meat appears well marbled. It does not, however, simulate all the characteristics of well-marbled meat from feedlot cattle.

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Air Purification for Apple Storages[a]

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(Manuscript submitted June 15, 1953)

Activated carbon as a volatile adsorbent for apple storages was studied over a two-year period. Air purification achieved by use of activated carbon was not shown to benefit 7 varieties of apples stored at 31.5° F. Final judgment, however, must await definitive data concerning the ability of volatiles from ripe fruit to stimulate pre-climacteric fruit at cold storage temperatures.

The term *air purification* has never been officially defined, but is taken to mean the removal from the atmosphere of certain gases foreign to the established composition of pure air. In the case of meat and dairy product storages it refers to the removal of various decomposition gases produced from bacterial, mold or enzymatic action, and in the case of fruit storages, mainly to the elimination of various metabolic gases arising from the respiration and ripening of fruit. The material ordinarily used for purifying air in fruit storages is activated coconut shell carbon. Air purifiers have been fairly extensively installed in apple storages, and four companies are actively engaged in their manufacture.

Charcoal has long been known for its adsorptive properties. The ability of charcoal to remove colours and odours from liquids, has been known since the 15th century though it was not until the close of the 17th century that this property was put to practical use. Bone black or char, the carbonaceous residue from the dry distillation of animal bones in closed vessels was for many years a key material for decolourizing syrup in the refining of raw sugar *(9)*.

However, the last 40 years have seen the development of a range of activated carbons whose adsorptive capacities are many times greater than that of bone char. Activated coconut shell carbon is an important member of this group and gained great prominence during World War I as the adsorbent used in army anti-gas respirators. The range of use of activated carbons is enormous, including purification of syrups, fruit juices, wines, vinegars, gelatines, various organic chemicals and a wide application as a solvent recovery agent for dry cleaning and other industrial purposes. Carbons are also extensively used for removing taste and odour from water supply systems.

The efficiency of activated carbon as an adsorbent is a function of its surface area which has been estimated to represent as much as 4.5 acres per cubic inch. It has also been estimated that a certain brand of activated carbon contains 120,500,000,000 particles per gram. The exact mechanics of adsorption have never been entirely explained, but include the factors of surface action, electrical charges and chemical activity.

Optimum adsorption rates for activated carbons vary with physical conditions. Thus, in the case of materials in solution, lowering the pH and raising the temperature usually increase rate of adsorption while less soluble substances are more easily adsorbed than more soluble materials. In the case of volatile substances, adsorption is increased by lowering the temperature. Adsorption is normally a rapid process, but its speed is governed by the suitability of environment. Carbons eventually reach a state of saturation when they have to be replaced and the spent carbon reactivated. Activation is carried out under patented processes using air, steam, carbon dioxide, chlorine and other chemicals, depending upon the purpose for which the carbon is to be used.

REVIEW OF LITERATURE

Kidd and West *(8)* in 1933 were first to report that respiration of preclimacteric apples could be stimulated by additions of ethylene or ripe apple volatiles to the storage air. Smock *(11)* in 1943 reported on the stimulatory effects of vapours of climacteric and post-climacteric apples on ripening of preclimacteric McIntosh and other varieties. These experiments showed that remarkable increases in rate of tissue softening occur when ripe app'e vapours are passed over unripe fruit, at room temperatures, but little or no response at a temperature of 33° F. Attempts to remove the stimulatory gases with different adsorbents indicated that the only effective treatment was brominated activated charcoal. Experiments reported by Walls *(20)* in 1942 indicated that activated carbon was effective in adsorbing ethylene only at ca —40° C. and from a moisture-free atmosphere.

Further experiments reported by Smock in 1944 *(12)* with Duchess, Wealthy and Golden Delicious indicated that brominated activated carbon was a successful agent for removing ethylene evolved by fruit, while the ineffectiveness of plain activated carbon was ascribed to high relative humidity in the storage atmosphere. Data published by Southwick *(16)* 1945 demonstrated that activated charcoal was effective in removing from the atmosphere that fraction of apple volatiles which is reactive with concentrated sulphuric acid. Ethylene, however, could only be removed from the atmosphere by the addition of elemental bromine to the activated charcoal.

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In 1948 Smock and Southwick *(13)* presented extensive data on semi-commercial application of air purification to fruit storages involving 19 separate tests over a 3-year period. Activated coconut shell carbon (in some cases brominated) was used and storage temperatures were maintained at 32° F. They reported that "when the results with all varieties were averaged together over the 3-year period, it was found that air purification with unbrominated carbon would add about 3 weeks to the storage life of apples." They surmised that "the effect of air purification on added storage life is presumably due to the removal of naturally evolved ethylene."

With respect to scald they *(13)* found that good scald control was obtained when single varieties were stored alone, but not when mixed varieties were stored together. On the average, air purification with plain activated carbon gave us good scald control as did shredded oil paper, but in the study as a whole, scald control was erratic. In a further paper (1948) Southwick and Smock *(17)* working with McIntosh, Cortland and Greening reported at storage temperatures ranging (in different tests) from 33° to 36° F. that activated coconut shell carbon added from 1 to 2 months' life to the fruit and that in mixed variety rooms it gave better scald control than shredded oil paper.

In 1948 Van Doren *(18)* reported results of a commercial air purification trial in Wenatchee, Washington. The room with carbon air purification had a capacity of 40,000 boxes, was equipped with diffusers and ducts and was maintained at 32° F. Five hundred and fifty pounds of activated carbon were used for volatile removal. The check fruit was held at 32° F. in a large commercial plant with central reverse air distribution. Ten varieties, picked at 4 different maturities were placed in both air purified and check storages. On April 3rd all lots were examined, and it was concluded, on the basis of pressure tests, that air purification with activated coconut shell carbon added about a month to the storage life of the apples and provided similar protection against scald as did oiled wraps.

Fidler *(11)* in England in 1948 reported the results of experiments to reduce scald in gas storage using activated carbon filters with and without bromine. He found that complete removal of volatiles from the atmosphere with filters was impracticable; that the reduction of the odorous fraction did not reduce scald; but the reduction of the odorous fraction plus ethylene did give some measure of scald control.

Hansen *(7)* has studied the use of air purification in lengthening the keeping life of Anjou pears. While preliminary laboratory scale tests seemed to indicate marked reduction in rate of softening and longer retention of green skin colour where carbon was used, his later work *(7)* in commercial storages indicated only a very slight advantage in firmness of carbon-treated over check fruit. Air analyses showed carbon to be ineffective in ethylene removal and only partially effective in removal of other volatiles. In a recent letter (Jan. 1953) Hansen stated, "While air purification in pear storage may produce observable results under certain conditions, the benefits are not great enough to justify commercial application."

In 1950 Van Doren *(19)* again reported on commercial scale tests on application of air purification to Washington State fruit storages. He compared 2 different commercial units with a home-made unit containing an amount of carbon equivalent to the commercial units. He ran 4 series of tests in different warehouses using 5 varieties of apples and 2 of pears. With one make of air purifier he obtained increased firmness and keeping life of fruit which was apparent 3 weeks after the fruit was removed from 32° F. to 70° F. storage. With the other commercial make of air purifier and with the home-made unit, no significant differences in keeping life of fruit were noted. He ascribed this ineffectiveness respectively to (a) poor grade of carbon and (b) faulty construction of the unit.

In 1950 Gerhardt *(2)* reported on the efficiency of activated coconut shell carbon for volatile removal in controlled laboratory experiments on a semi-commercial scale and also in large installations in commercial fruit storages. The laboratory tests of carbon-treated air versus no carbon were conducted at 35° F. under identical conditions of humidity and air circulation. Bartlett and Anjou pears, Jonathan, Red Delicious and Golden Delicious apples, picked at a range of maturities, were all stored together to simulate commercial packing house procedure.

Activated coconut shell carbon did not reduce ethylene either in the laboratory trials or in commercial storages, nor did air purification in commercial installations appreciably reduce the level of other volatiles over that in check rooms. In the semi-commercial laboratory trial, however, the odourous volatile fraction was lowered by activated carbon to approximately one-third the value in the check room.

In terms of firmness, soluble pectins, and scald reduction, early harvested Bartlett showed an advantage in favour of air purification, but not sufficient to influence dessert quality. Apple scald was somewhat reduced in intensity on early harvested Red Delicious in carbon treated air, but air purification did not prolong storage life or improve ripening capacity or dessert quality of Red Delicious, Golden Delicious or Jonathan apples or Anjou pears.

Further experiments by Gerhardt and Sainsbury *(3)* using the same experimental storage rooms as above, but this time comparing brominated and unbrominated carbon for air purification, were reported in 1951. In addition to the experimental fruit, each carbon room received 125 boxes of cull Delicious. Conditions in the check room were not directly comparable since this room did not receive any ripe culls, but instead periodic increments of ethylene, amyl alcohol, amyl valerate, amyl acetate and acetaldehyde. Moreover, it received more ventilation through opening of doors than the other rooms. Experimental fruit consisted of Bartlett and Anjou pears and McIntosh, Red Delicious, and Golden Delicious apples picked at different maturities. This test proved that brominated carbon was a more efficient adsorbent of ethylene than plain activated carbon, but both kinds were effective for volatiles other than ethylene. It was not possible to detect or measure any significant improvement in rate of softening, ripening capacity, or dessert quality of pears and apples stored in air purified by passage through either activated or brominated carbon. Scald intensity was reduced by air purification, but was controlled more effectively and economically with oiled fruit wraps.

Grierson-Jackson *(5)* in 1951 and *(6)* in 1952 constructed a miniature laboratory model cold storage and in it attempted to simulate volatile concentrations and methods of refrigeration application and defrosting as found in commercial apple storages. Non-ethylenic volatiles were found to condense on the evaporator coils in considerable quantities and could be removed in substantial amounts by water defrosting or brine spray refrigeration. He states *(5)* that "On the miniature scale, at least, the brine spray seemed to be a very effective air purification measure."

Grierson-Jackson *(5)* also attempted to assess reasons for success or failure with commercial air purification installations, and pointed out that in small storage rooms speedily loaded with one variety, and thereafter only infrequently entered, volatile accumulations would likely reach a much higher level than in large commercial storages with heavy in-and-out traffic and therefore frequent dilution of volatile content from ventilation with outside air. He was therefore "inclined to favour air purification in tightly-built storages with comparatively small rooms, but not in large storage rooms subject to heavy in-and-out traffic."

Two recent 1952 publications by Smock *(14, 15)* express this author's most recent evaluation of air purification. He contends that "air purification will tend to protect our good apples from riper apples in storage" where activated coconut shell carbon is used at the rate of 6 pounds per 1,000 boxes of apples and with air movement through this amount of carbon at the rate of 100 cubic feet per minute. He agrees that air purification can be accomplished by ventilation. He emphasizes that air-purification can be effective only with preclimacteric fruit, promptly stored, and in a storage with good air circulation. He states that air purification makes good storage better and results in an extension in storage life of 3 weeks for Greenings and 4 weeks for McIntosh. He claims that air purification with carbon can reduce scald, but does not always control it as effectively as do oiled wraps. He agrees with other investigators that air purification is effective in reduction of odours from boxes and other sources in the storage room.

Poapst and Phillips (1952) reported a lower trend in formation of soluble pectin in Lawfam apples stored at 32° F. with activated carbon or under fresh air ventilation than in check fruit.

The most recently published account of air purification experiments is presented by Gerhardt *et al. (4)* 1953. They compared the keeping quality of Red Delicious, Golden Delicious and Rome Beauty apples and Anjou pears stored with activated carbon, brominated activated carbon and no air treatment. Based on pressure tests, soluble pectin formation, organoleptic evaluations and scald control, the authors found no significant advantages in favour of fruit stored under air purification as compared with controls.

EQUIPMENT AND METHODS

Air purification experiments were conducted at this Station in the 1950-51 and 1951-52 seasons. In order to conduct the experiment under precisely comparable conditions 2 cold storage chambers measuring 6 x 12 x 10 feet were used. Both rooms were refrigerated by forced air water defrost unit coolers and were held at 31.5° F. Defrost water was drained away from the rooms. Humidity was maintained at 85 to 95%. The rooms were insulated, walls and ceiling, with asphalt-impregnated cork board and plastered. The floor consists of a concrete topping over cork board insulation. The doors were opened momentarily once per day to inspect the evaporator coil for frosting. The only experimental variable was the inclusion in one room of a Pur Air purification unit. This unit consists of a fan and 2 trays of activated coconut shell carbon, each tray containing seven pounds of carbon. According to work reported by other investigators, this should be ample carbon to handle at least 1,400 packed boxes of apples for a season. Because of space limitations in the experimental chamber, only 140 boxes were included in each treatment. Thus the adsorptive potential of the carbon was approximately 10 times that which was required. On the other hand, this surplus of carbon gave a more than fair opportunity for the equipment to show what benefit could be produced by adsorption of apple volatiles from storage air. In the second season replacement trays of activated coconut shell carbon were obtained from the Crop King Company in Yakima.

Eight varieties were placed in each room in order of harvest, i.e., McIntosh, Jonathan, Delicious, Red Delicious, Stayman, Newtown, Winesap and Rome Beauty. All fruit was picked at normal commercial harvesting maturity for the variety and placed in storage within 48 hours of picking. Core temperature was reduced to 31.5° F., within 4 days of entering storage. Half of the fruit was stored loose and half was packed in dry wraps. Oiled wraps were not used because knowledge of the effect of the carbon treatment on scald control was desired.

The treatments and varieties used were the same in both 1950 and 1951 except that in 1951 for the first 6 weeks of storage, both rooms were held at 35° F. and then reduced to 31.5° F. Since the 35° F. temperature simulates that found in some commercial storages during the harvest season it was felt that the carbon might prove to be more effective in combating the effects of the higher physiological activity of the fruit resulting from 35° F. storage.

Samples of fruit from each lot were pressure tested at picking and at regular intervals during storage with a Ballauf tester using a $\frac{7}{16}$ inch point. Starting in December, soluble pectin determinations were carried out according to the Carre and Haynes procedure, using composite juice samples prepared from 20 representative apples.

In both seasons the fruit was removed from storage in mid March and examined for appearance, flavour and firmness by a panel of shippers, inspectors and other industry officials. All lots were coded to prevent their identification as treated or check fruit. Data on volatile content of atmosphere during carbon and check runs are given for 1952 season.

DATA FOR 1950-51 SEASON

Firmness of fruit. The effect of air purification on rate of softening of different varieties is given in Table 1. These data indicate that while there were slight differences in firmness between treatments and checks, in no cases were the differences sufficiently great or consistent to ascribe any benefits to air purification.

Examination of fruit, March 21. One box of apples of each variety was removed from both air-purified and non air-purified storage on March 12. The fruit was held at a temperature of 65° F. until March 21st to simulate commercial handling conditions. It was examined on March 21st along with similar boxes of treated and check fruit freshly removed from cold storage the previous day.

Twenty-four judges examined the fruit and entered their scores on a uniform report sheet which evaluated firmness, flavour and appearance. Under *firmness*, fruit was rated as *hard, hard ripe, firm, firm ripe* and *ripe*, which for purposes of tabulation was evaluated at 5, 4, 3, 2 and 1 points, respectively. Under *flavour*, fruit was rated as *good, fair to good, fair, fair to poor, poor*, and *stale*, valued at 6, 5, 4, 3, 2 and 1 points, respectively. Under *appearance* scoring was 3 points for *bright*, 2 points for *medium* and 1 point for *dull*. The total score for each lot, based on 24 evaluations, was then compared; and data are given in Tables 2 and 3.

From these data it is apparent that no consistent differences between treated and check fruit could be detected by the composite opinion of 24 judges. This finding was confirmed by a careful examination by technical officers of the Experimental Station who likewise could detect no difference in fruit condition between treated and control fruit.

Effect of air purification on control of storage scald and soft scald. Storage scald was noted in some lots of Delicious and Stayman and soft scald in Jonathan. In order to determine the extent of these disorders, counts of affected fruits were made after apples had received nine days of 65° F. temperature following removal from cold storage. With Rome and Jonathan, 4 boxes of fruit were counted, and with other varieties one box per variety. The data are given in Table 4.

The only varieties in which significant amounts of scald developed were Stayman and Red Delicious, both of which were harvested a few days immature. Scald was most severe in all Stayman used in the experiment, whether treated or control lots. With other varieties, there was a slight scald development, but not significantly different amounts between treatments. On the whole, slightly more scald is reported with air-purified as compared with check fruit, but the differences are more likely due to sampling errors than to intrinsic differences.

Slight soft scald was found in some lots of Jonathan, but no significant improvement due to storage of fruit under air-purification was noted.

DATA FOR 1951-52 SEASON

Firmness of fruit. Data are presented in Table 5 to depict progressive changes in firmness of different varieties, stored

TABLE 1

Influence of activated carbon air purification upon firmness of apples during the storage season

Variety	Date harvested	Firmness of fruit examined on:									
		At picking	Nov. 1		Dec. 7		Jan. 1		Feb. 8		March 15	
			Carbon	Check	Carbon	Check	Carbon	Check	Carbon	Check	Carbon	Check
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
McIntosh	Sept. 28	13.4	13.2	13.0	11.2	11.1	9.7	9.8	9.7	10.0	9.5	9.7
Jonathan	Oct. 4	14.7	15.1	15.5	14.9	14.7	11.9	13.1	11.5	11.4	11.5	11.5
Delicious	Oct. 2	16.5	15.8	15.8	14.7	15.2	13.0	13.3	12.4	12.5	11.7	10.4
Delicious	Oct. 12	16.7	15.5	16.0	14.9	13.4	13.2	11.9	11.5	11.3	11.2	11.4
Red Delicious	Oct. 10	17.1	16.3	16.6	16.4	16.2	14.6	14.3	14.6	13.8	15.0	12.8
Stayman	Oct. 13	18.2	17.0	16.7	16.9	16.6	14.4	13.9	13.1	12.3	12.6	12.1
Newtown	Oct. 16	18.2	18.4	18.1	17.5	17.2	16.8	17.0	16.4	15.8	15.5	15.4
Winesap	Oct. 20	20.7	20.1	19.3	18.2	18.4	17.0	17.9	16.4	16.8	16.1	15.6
Rome Beauty	Oct. 25	17.6	17.6	17.3	16.7	16.6	14.0	14.7	13.6	13.6	12.3	12.6

TABLE 2

Influence of activated carbon air purification upon appearance, flavour and firmness of apples. Composite rating of 24 judges. Apples removed from 31.5° F. storage to 65° F. on March 20/51 and examined on March 21/51

Variety	Treatment	Appearance (Possible 72)	Flavour (Possible 144)	Firmness (Possible 120)
McIntosh	Carbon	65	112	56
	Check	68	99	53
Jonathan	Carbon	66	113	44
	Check	65	108	44
Delicious (Oct. 2)	Carbon	61	105	56
	Check	64	116	52
Delicious (Oct. 12)	Carbon	69	125	59
	Check	63	104	51
Red Delicious	Carbon	69	130	58
	Check	70	126	55
Stayman	Carbon	47	103	52
	Check	45	107	58
Newtown	Carbon	72	124	76
	Check	70	125	73
Winesap	Carbon	70	118	75
	Check	68	124	80
Rome	Carbon	68	113	61
	Check	67	118	61

TABLE 3

Influence of activated carbon air purification upon appearance, flavour and firmness of apples. Composite rating of 24 judges. Apples removed from 31.5° F. storage to 65° F. on March 12/51 and examined on March 21/51

Variety	Treatment	Appearance (Possible 72)	Flavour (Possible 144)	Firmness (Possible 120)
McIntosh	Carbon	54	87	39
	Check	55	98	34
Jonathan	Carbon	55	82	41
	Check	48	87	38
Delicious (Oct. 2)	Carbon	37	73	24
	Check	41	73	35
Delicious (Oct. 12)	Carbon	51	85	41
	Check	39	74	40
Red Delicious	Carbon	50	85	39
	Check	50	91	42
Stayman	Carbon	29	85	42
	Check	33	72	37
Newtown	Carbon	67	109	69
	Check	67	117	70
Winesap	Carbon	63	104	71
	Check	63	108	70
Rome	Carbon	63	77	50
	Check	55	90	43

both with and without carbon air-purification. These data indicate that within the range of sampling variation, no consistent or significant differences could be found between treated and check fruit.

On March 11 sample boxes from each lot were removed from cold storage for a panel examination and after 8 days at 65° F. were again pressure tested. These data which are given in Table 6 again indicate that following a period of 8 days at warm temperatures no significant differences in firmness could be discerned between fruit held with or without air-purification.

Soluble pectin changes. The conversion of protopectin to soluble pectin is a normal physiological process in the ripening of apples. The speed at which this change takes place is often used as an indicator of degree of ripeness of fruit. For this reason soluble pectin determination were made at regular intervals throughout the storage season. Composite juice samples were prepared from 20 representative apples on each date of analysis.

TABLE 6

Influence of air purification on firmness of apples nine days following their removal from 31.5° F. to 65° F.

Variety	Firmness by pressure tester	
	Air purification	Check
	lbs.	*lbs.*
McIntosh	10.1	10.1
Jonathan	10.8	11.2
Red Delicious	12.4	12.0
Stripe Delicious	13.1	12.7
Newtown	15.6	14.9
Winesap	13.8	14.5
Rome Beauty	12.4	13.3

The amount of soluble pectin reported is the amount contained in 40 ml. of juice. The data for air-purified samples are given in Table 7. These data indicate very little difference between samples on different dates with the exception of a greatly reduced

TABLE 4

Influence of activated carbon air purification upon incidence of storage scald and soft scald in apples

Variety	Date examined	No. of apples examined		Amounts of			
				Storage scald		Soft scald	
		Carbon	Check	Carbon	Check	Carbon	Check
				%	%	%	%
Delicious (Oct. 2)	Apr. 2	114	112	35.8	18.2	0	0
Delicious (Oct. 12)	Mar. 22	81	90	5.0	6.7	0	0
Red Delicious	Mar. 29	79	73	29.0	25.0	0	0
Stayman	Mar. 22	70	79	98.5	86.0	0	0
Winesap	Mar. 22	103	112	1.2	14.3	0	0
Rome	Apr. 17	435	444	12.2	7.9	0	0
Jonathan	Apr. 17	441	439	0	0	5.3	3.9

TABLE 5

Influence of activated carbon air purification upon firmness of apples during the storage season

Variety	Date harvested	Firmness at picking	Firmness of fruit examined on:											
			Nov. 14		Dec. 21		Jan. 28		Feb. 25		Mar. 18		April 10	
			Carbon	Check	Carbon	Check	Carbon	Check	Carbon	Check	Carbon	Check	Carbon	Check
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
McIntosh	Sept. 21	15.5	12.1	12.1	10.6	11.3	11.0	11.0	11.2	11.5	9.9	9.9	9.7	9.8
Jonathan	Sept. 22	15.2	13.4	14.1	12.3	12.5	11.4	11.9	11.4	11.2	11.2	10.6	10.5	10.9
Red Delicious	Oct. 10	17.3	16.2	17.8	15.5	15.8	14.6	14.4	14.3	14.8	13.4	12.9	14.0	14.6
Stripe Delicious	Oct. 12	16.9	16.9	16.3	15.6	14.5	13.6	12.9	13.5	13.1	13.2	13.2	13.0	11.9
Newtown	Oct. 15	18.8	18.1	20.5	17.6	18.4	16.8	16.7	17.3	15.5	15.2	14.9	15.7	15.2
Winesap	Oct. 17	21.3	20.0	19.6	19.6	18.5	17.0	16.6	15.9	15.6	14.7	14.4	15.9	16.0
Rome Beauty	Oct. 22	20.2	19.5	19.3	17.7	17.7	15.6	15.0	14.9	14.3	13.9	13.4	14.5	14.7

35° F. until Nov. 1
31.5° F. after Nov. 1

TABLE 7

Influence of carbon air purification upon soluble pectin formation in apples during the storage season

Variety	Treatment	Soluble pectin contained in 40 ml. apple juice on:		
		Nov. 16	Jan. 28	April 8
		mg.	*mg.*	*mg.*
McIntosh	carbon	15.6	20.8	26.5
	check	14.0	19.5	26.6
Jonathan	carbon	4.1	16.9	20.6
	check	4.7	14.5	20.0
Red Delicious	carbon	1.1	5.6	5.2
	check	1.7	6.0	5.8
Stripe Delicious	carbon	4.8	3.4	12.0
	check	4.7	5.8	12.5
Newtown	carbon	1.1	12.9	9.3
	check	1.2	8.3	13.8
Winesap	carbon	1.3	2.0	9.1
	check	2.3	3.5	20.6
Rome Beauty	carbon	1.6	28.8	29.2
	check	1.5	32.1	30.0

soluble pectin value for air-purified Winesap on all dates of analysis. In view of the lack of difference between air-purified and check fruit of other varieties stored in the same room, it is likely that the lower soluble pectin value for air-purified Winesap is the result either of sampling or analytical error. This difference is not borne out by a coresponding difference in fruit firmness on the April examination.

Examination of fruit, March 19. One box of air-purified and check apples from each variety was removed from 31.5° F. storage on March 11 and held at 65° F. until March 19. A similar withdrawal of fruit was made on March 18 and placed in 65° F. storage. Both lots were examined on March 19, the first lot to represent fruit held for a week at retail store temperatures and the second lot of fruit to represent fresh cold storage stock. All lots were placed under code number to conceal their identity and were critically examined for appearance, flavour and firmness by a group of *22* judges who represented packing house managers, inspectors and other industry officials. Each condition characteristic was rated as *good, fair* or *poor* with a respective numerical evaluation of *3, 2* and 1. Thus the possible top score under any category would be *22* x *3* = *66*.

The scores of all judges were averaged for each characteristic and are presented in Tables 8 and 9. A critical examination of these tables fails to reveal any consistent or significant differences, between fruit stored under air-purification as compared with checks, whether examined directly out of cold storage or following 8 days at 65° F.

Volatile levels in storage rooms. No measurements of volatile content of the storage atmosphere in the carbon and check rooms were made in 1950 and 1951. However, during this past season *3* pairs of volatile determinations were made in the carbon room which contained a somewhat similar quantity and assortment of apple varieties to that used in the *2* years the air-purification experiments were in progress. In each pair of runs the same quantity of fruit was present in the room. In the case of the January 14 and January 21 runs volatile content of the room was lower owing to the removal on January *2* of one-third of the fruit from the room.

A "check" run was first obtained over a *24*-hour period. The fan of the air purification unit was then turned on and *6* or *7* days later a further run was obtained to determine the effect of carbon adsorption on volatile content of the air. The quantities of air in each run were accurately measured with a wet test meter and the ethylene and "other volatile" content was determined by the method of Gross (unpublished). The results obtained are reported in Table 10.

These data indicate slight but inconsistent differences in ethylene content between carbon and check runs. This finding, however, is not at variance with work of other investigators *(11, 12, 20)* who have shown that ordinary activated carbon at cold storage temperatures is ineffective in adsorbing ethylene. With the exception of the first test, however, other volatiles were significantly lower in the carbon than in the check treatments. Both ethylene and other volatiles were present at relatively low levels in either instance. In a later paper Porritt will report on volatile levels encountered throughout the season in two commercial cold storages.

CONCLUSIONS

This paper reviews the background of activated carbon as a volatile adsorbent for apple storages and presents further data based on two years of experimental work. The experiment, conducted under carefully controlled conditions at 31.5° F. with *7* varieties

TABLE 8

Influence of activated carbon air purification upon appearance, flavour and firmness of apples. Composite rating of 22 judges. Apples removed from 31.5° F. storage to 65° F. on March 18/52 and examined on March 19/52

Variety	Treatment	Appearance	Flavour	Firmness
McIntosh	carbon	47	44	39
	check	50	45	40
Jonathan	carbon	29	27	20
	check	32	22	21
Red Delicious	carbon	56	52	48
	check	57	48	52
Stripe Delicious	carbon	56	54	52
	check	60	51	54
Newtown	carbon	64	55	63
	check	62	54	62
Winesap	carbon	59	58	62
	check	60	51	59
Rome Beauty	carbon	60	54	55
	check	60	49	51

Possible score for good appearance, flavour and firmness, 66.

TABLE 9

Influence of activated carbon air purification upon appearance, flavour and firmness of apples. Composite rating of 22 judges. Apples removed from 31.5° F. storage to 65° F. on March 11/52 and examined on March 19/52

Variety	Treatment	Appearance	Flavour	Firmness
McIntosh	carbon	48	36	35
	check	39	34	36
Jonathan	carbon	28	27	22
	check	25	28	22
Red Delicious	carbon	45	47	47
	check	47	47	42
Stripe Delicious	carbon	48	41	43
	check	47	35	40
Newtown	carbon	52	50	56
	check	49	54	64
Winesap	carbon	57	47	52
	check	60	50	59
Rome Beauty	carbon	48	41	42
	check	58	40	50

Possible score for good appearance, flavour and firmness, 66.

TABLE 10

Influence of air purification on volatile content of atmosphere in experimental storage rooms, 1952-53

Date	Treatment	Volume of air analyzed	Volatile content	
			Ethylene	Other volatiles
		cu. ft.	*mg./cu. ft.*	*ml. IN Ce $(SO_4)_2$ reduced/ cu. ft.*
Dec. 5	Check	27.7	.224	.088
Dec. 11	Carbon	31.5	.226	.097
Dec. 17	Check	31.5	.202	.055
Dec. 24	Carbon	27.4	.156	.035
Jan. 14	Check	29.25	.073	.055
Jan. 21	Carbon	34.0	.093	.028

of apples, failed to reveal any superiority in keeping quality of air-purified over check fruit. The evaluation of fruit condition was made by a panel of over twenty judges experienced in the appraisal of apples. The appraisal of the fruit was made on the basis of firmness, flavour and appearance and each lot was examined both at time of removal from 31.5° F. and after an interval of 8 or 9 days at 65° F. Pressure tests and soluble pectin determinations taken at regular intervals throughout the storage season failed to indicate any improvement in firmness of air-purified as compared with check fruit.

It is recognized, however, that there are investigators who are convinced that the effects of air-purification for apples are not only measurable but sufficiently striking to warrant the investment of considerable sums of money on air purification equipment. Further experimental work seems desirable in an attempt to resolve these two viewpoints.

However, there can be no fundamental basis for judging the merit of air purification for apple storages until undisputed knowledge is available concerning the ability of volatiles from ripe fruit to stimulate preclimacteric fruit at cold storage temperatures (30° to 36° F.), and if this stimulation does take place, the minimum level of ethylene or other volatiles necessary to cause a measurable response.

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Dehydrated Stabilized Egg. Importance and Determination of pH[a,b]

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(Manuscript received June 14, 1953)

A method for determining the pH of dehydrated stabilized egg is described. The pH measurement is made on the reconstituted sample after it has been cooked. The method is shown to be valuable as a control test since it is more sensitive to acidity and alkalinity than when uncooked eggs are used. To determine the pH range that describes the most desirable product consumer and laboratory tests were applied, respectively, to scrambled eggs and to sponge cakes (prepared from dehydrated stabilized eggs) of varying pH. A suitable range for the pH of cooked reconstituted dehydrated egg was shown to be from 7.0 to 9.0. Formations of green color under conditions of heat and high pH were noted. The reaction apparently involving iron and sulfur compounds can be inhibited by a metal-complexing agent.

[a] Presented at the Thirteenth Annual Meeting of the IFT, Boston, Mass., June 23, 1953.

[b] This paper reports research undertaken by the Quartermaster Food and Container Institute for the Armed Forces and has been assigned No. 437 in a series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

A number of processes are being used for stabilizing the flavor, color, solubility and other desirable properties of dehydrated egg during storage. Among these are gas packing, drying to very low moisture content, removal of glucose by fermentation, enzymatic oxidation of glucose, and acidification. The acidification process was first reported by Stewart, Best and Lowe *(5)* who

used 10% lactic acid for adjusting the pH prior to drying. They found that acidification had a marked beneficial effect on solubility, but that lowering the pH below 6.5 caused an objectionable alteration in flavor and texture. Boggs and Fevold *(2)* used dilute hydrochloric acid and found that acidification of egg emulsion to the pH of egg yolk, 5.5, improved markedly the retention of palatability during storage. These workers reconstituted the acidified egg powder with sodium carbonate equal to the acid used in acidification in order to prevent undesirable textures from developing during heating. Conrad *et al. (3)* state that when sodium bicarbonate is used for neutralizing the acid, the correct amount to add to the acidified powder is 1.5% of the weight of powder.

In order to realize the benefits of these developments for the Armed Forces, the Quartermaster Corps, in 1949, adopted the acidification process for the production of powdered egg. The product, called Egg, Stabilized, Dehydrated, is manufactured by a process designed to improve the flavor stability. After the liquid egg is pasteurized, it is acidified with hydrochloric acid to a pH of 5.5 and then spray dried. Sodium bicarbonate is added to the egg powder at the plant in order to restore the normal pH at the time of reconstitution and use.

Research at the Quartermaster Food and Container Institute has demonstrated that the flavor, color and functional properties of stabilized egg are adversely affected by either inadequate or excessive amounts of sodium bicarbonate. Furthermore, the addition of sodium bicarbonate in quantities beyond those actually needed would have the same monetary effect as an equivalent adulteration of the product. One objective of this study was to establish pH limits for dehydrated stabilized egg which would insure the presence of the optimum level of sodium bicarbonate.

During reconstitution of dehydrated stabilized egg, carbon dioxide is generated by the reaction between hydrochloric acid and sodium bicarbonate. Because of the difficulty of obtaining reliable pH measurements in the presence of carbon dioxide, a second objective of this study was to develop a dependable method for measuring the pH of this product.

Tests indicate that samples which give a certain pH value when one method of reconstitution is followed may not give the same value when the manner of mixing is changed. The variable nature of pH measurements is demonstrated by the data in Tables 1 and 2. Loss of carbon dioxide from the mixture causes the pH value to rise, and the final acidity depends upon the extent to which the carbon dioxide is liberated. The efficiency and speed of the mixer, the time of mixing, the degree of aeration, and the temperature influence the rate of liberation of carbon dioxide. The pH value of acidified powder to which no sodium bicarbonate had been added was found to be independent of the manner of mixing.

In order to obtain consistent results, it is necessary to remove carbon dioxide under uniform conditions. By defining the brand name and type of mixer and the time for mixing, uniform results can be obtained. For example, with 30 seconds of blending in 4 different Waring blenders,[a] the pH values of a commercial sample were 7.3, 7.4, 7.4 and 7.4. However, it is desirable to avoid specification tests which are restrictive with regard to equipment requirements. For that reason, the possible advantages of heating the samples to remove carbon dioxide were investigated. On the basis of data published by Conrad *et al. (3)*, it appeared that variations in acidification and neutralization were reflected best by the pH of cooked, rather than uncooked, reconstituted egg. Thus, in addition to providing the desired standardization of the test, cooking the samples should also give more informative results.

MATERIALS AND METHODS

Equipment.

(a) Balance and weights, for weighing to the nearest 0.1 g.
(b) Waring or similar food blender, with covered jars.
pH meter equipped with glass and calomel electrodes. (Five-inch Beckman electrodes with shielded leads for use external to the pH meter were used with a Beckman Model G meter.)
(c) Cooking apparatus (Figure 1).
a. No. 10 tin can, 6⅛ in. diameter, 7 in. high, provided with wire-screen shelf 2 in. above bottom.
b. Watch-glass cover, approximately 7¾ in. diameter, set in inverted position (convex side up) over can.
c. Source of heat.
(d) Thermometer.
(e) Crucible or beaker tongs.
(f) Cold water bath or trough.
(g) Spatula.
(h) No. 7 rubber stopper.
(i) Crystallizing dishes, approximately 4 in. diameter.
(j) Graduated cylinder, 50 ml.
(k) Beakers, 50 ml.
(l) Reference buffer solution (pH 4.0 and pH 7.0 buffers were used.)

[a] The mention of this and other commercial products does not imply that they are endorsed or recommended by the Department of Defense over other similar products not mentioned.

TABLE 1
Effect of method of reconstitution upon the pH of dehydrated stabilized egg

Method of mixing	pH									
	Time of mixing, minutes									
	½	1	2	3	5	6	10	20	40	50
Hand mixing in 250 ml. beakers		6.8								
Kahn Shaker, glass stoppered, Erlenmeyer flasks							6.9			
Glass paddle stirrer and motor										
Low speed					7.0			7.5		8.0
High speed			7.1		7.3		7.7	8.1	8.3	8.3
Hand Mixing 1.5 minutes followed by Hamilton Beach Malted Milk Mixer	7.5	7.8		8.1		8.3	8.3			
Waring blender	7.3	7.5		7.7						

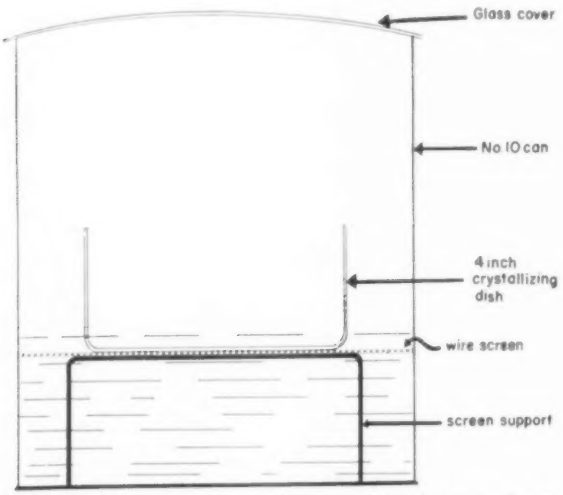

Figure 1. Apparatus for cooking reconstituted powdered egg.

Determination of pH. Pour water into the tin can until the surface is one-fourth to one-half inch above the screen shelf. Cover the can, heat to boiling, and keep boiling. Measure 27 ml. of distilled water into food blender jar and add 10.0 g. of egg powder. Cover the jar and blend for 30 seconds. Pour the reconstituted sample into a crystallizing dish, and, with tongs, set dish on the wire screen shelf of the boiling water bath and replace the cover. After 10 minutes, remove the dish and cool it in a water trough to 25° C. With the aid of a spatula, transfer the cooked egg to a 50 ml. beaker, press it down solidly with a No. 7 rubber stopper, and, if necessary, adjust the temperature to 25° C. Insert electrodes into the egg and determine the pH. Insert electrodes in a different position and read again. Repeat, if necessary, until readings are constant. The usual precautions with regard to standardization and use of the pH meter should be observed (11).

Preparation of scrambled eggs. The following formulas were used:

	With Milk	Without Milk
Acidified egg powder	70.3 g.	70.3 g.
Distilled water	198.0 ml.	236.0 ml.
Evaporated milk	50.0 ml.	----
Salt	0.9 g.	----
Soluble pepper in salt base	0.24 g.	----
Hydrogenated shortening	11.7 g.	11.7 g.

Sift egg powder, combine with water and mix for 30 seconds in Waring blender. Add milk, salt and pepper and mix well with spoon. Melt shortening in top of double boiler. The bottom of the double boiler should contain just enough water to provide a steam bath for the top. Pour reconstituted egg into hot shortening and cook for 4 minutes, stirring slowly as egg thickens. Cover cooked eggs, hold 20 minutes, then serve within 20 minutes.

Preparation of sponge cakes. The following formula was used for sponge cakes:

Eggs, dehydrated	58 g.
Sugar	200 g.
Water, 154° F.	172 g.
Salt	½ teaspoon
Cake Flour	96 g.

[Dry ingredients measured at 72° F. (22.2° C.)]

Use Kitchen Aid Mixer Model K4-B with wire whip. Partly submerge the mixer and bowl in hot water bath at a temperature of 113° F. during the entire mixing process.

Sift eggs and sugar together 3 times; sift salt and flour together 3 times. Mix egg-sugar mixture 1 minute at speed control number 1. Adjust mixer to speed control number 6 and add water slowly while beating. (This process should require approximately 45 to 60 seconds.) Continue beating on speed control number 6 until a specific gravity of 0.30 is reached or for a maximum beating time of 20 minutes. Stop mixer. Record temperature of egg mix, specific gravity and beating time.

Add 2 tablespoons of the flour-salt mixture. Start mixer again, using speed control number 1. Add the remaining flour-salt mixture gradually in a 30 second period. Stop mixer, scrape sides of bowl, and mix another 30 seconds on speed control number 1. Fold batter with a rubber spatula using 3 strokes around the bowl. Record temperature and specific gravity of the batter.

Scale 300 g. of batter into a tube pan of approximately 2000 cc. capacity which has been lined on the bottom with brown paper. Bake 25 minutes at 350° F. Determine pH on remaining sample of batter. Remove from oven, invert pan for approximately 24 hours, first on rack until cool and then on table. Determine the weight of the cake. Measure the volume by the rapeseed displacement method.

RESULTS AND DISCUSSION

Determination of pH after cooking. When reconstituted egg was heated in 250 ml. beakers on a steam bath, results of pH measurements on commercial samples were not uniform. Without stirring, the pH difference between cooked and uncooked samples was approximately 0.1 unit. With stirring, the difference was approximately 1.1 units. The apparatus illustrated in Figure 1 was adopted as the source of heat for cooking. The beakers were replaced by 4-inch crystallizing dishes and the sample size was reduced without altering the sample-to-water ratio. Instead of 27 g. of egg and 73 ml. of water, as used in preliminary experiments, 10 g. of egg were reconstituted with 27 ml. of water. The sevenfold increase in surface-to-volume ratio made stirring unnecessary and permitted thorough cooking in a few minutes with complete removal of carbon dioxide. The same pH values were obtained with 5, 10 and 15 minutes of cooking. A 10-minute period was used for the determinations reported here. A 5° C. rise in the temperature of the cooked egg at the time of measuring the pH resulted in a lowering of the pH value of approximately 0.1 unit.

Whereas the mixer and mixing time influence the pH of uncooked reconstituted egg (Tables 1 and 2), these factors have little or no effect upon the pH of the cooked egg (Table 2). Uniformity of results is the first advantage derived from cooking the reconstituted sample before measuring the pH. The samples were reconstituted with a Hamilton Beach malted milk mixer, with a Waring blender, and by hand mixing. In any column of Table 2 the greatest spread of results after cooking is 0.2 of a pH unit, whereas the spread of results before cooking is 0.5 to 0.7 of a pH unit. Therefore, if the sample is cooked before the pH is measured, the method of reconstitution is not critical.

Inspection of the data in Table 2 reveals other advantages of the cooking procedure. The increments in the pH values of the cooked eggs resulting from increases in the effective sodium bicarbonate concentrations are usually double or triple the corresponding increments for the uncooked samples. Hence, a second advantage of cooking the reconstituted egg before determining the pH is the greater sensitivity of the method to variations in acidity and alkalinity.

When cooked, sample number 1 (unmodified; 1.5% column) is a normal bright yellow color, but sample number 2 (unmodified) presents an unpalatable dark

TABLE 2

Effect of method of reconstitution upon the pH of dehydrated stabilized egg, measured before and after cooking

Sample	Condition	Method of mixing	pH				
			Nominal sodium bicarbonate (percent)				
			0[a]	0.75[a]	1.5[b]	2.25[c]	3.0[c]
1	Uncooked	(A) Hand mixed 1 minute			6.8		7.2
		(B) Malted milk mixer, 20 seconds			7.2		7.7
		(C) Waring Blendor, 20 seconds			7.3		7.5
	Cooked	(A)			8.5		9.3
		(B)			8.5		9.5
		(C)			8.4		9.5
2	Uncooked	(A)	6.2	6.6	6.9	7.1	
		(B)	6.8	7.3	7.6	7.8	
		(C)	6.6	7.1	7.4	7.5	
	Cooked	(A)	7.3	8.8	9.4	9.6	
		(B)	7.4	8.6	9.3	9.7	
		(C)	7.4	8.8	9.4	9.6	

[a] Commercial powder, modified by addition of standard hydrochloric acid solution.
[b] Commercial powder, unmodified.
[c] Commercial powder, modified by addition of sodium bicarbonate.

green appearance. The green color is apparently the result of changes initiated by an over-alkaline condition, since it can be produced in sample number 1, also, by adding to it excessive amounts of sodium bicarbonate (modified; 3.0% column). The uncooked samples reconstituted with the Waring blender (1.5% column) have nearly the same pH, 7.3 and 7.4, whereas the pH values after cooking are very different, 8.4 and 9.4. The fact that sample number 2 is too alkaline is reflected by the pH of the cooked sample, but not by the pH of the uncooked sample. Also, the green color which develops on cooking is a simple practical test for over-alkalinity.

Additional comparisons of pH determinations made before and after cooking are presented in Table 3. Sample number 3 was bright yellow when cooked; sample number 4 when cooked was a dirty yellow. The pH values of these samples before cooking were 6.8 and 7.3, respectively, but after cooking they became more alkaline and the pH values, 7.4 and 8.7, show a much greater difference. The pH value of 7.7 determined on uncooked sample number 5 would indicate that not much excess sodium bicarbonate had been added. When cooked, however, this sample had an abnormally high pH (9.7) and a dark green color. Sponge cakes made with sample number 5 were a dark color and had texture and flavor defects.

In order to obtain the figures in the third column of Table 3, 20 ml. of an 0.088 M solution of hydrochloric acid plus 7 ml. of water were used for reconstitution of the dehydrated egg. Twenty ml. of the acid solution are equivalent to 0.15 g. of sodium bicarbonate, or 1.5% on a 10-gram sample of egg powder. If hydrochloric acid and sodium bicarbonate were used in equivalent amounts at the time of manufacture, the acid added in reconstitution should result in a pH value for the uncooked sample very near to 5.5. It is interesting to note that only sample number 3, the one which was bright yellow when cooked, gave such a value. In this instance, the pH values before and after cooking differed by only 0.3 unit. Presumably, the large excess of acid was nearly as effective as heat for removing carbon dioxide from the solution.

Much of the data in Tables 2 and 3 were obtained on commercial samples after they had been modified by the addition of either hydrochloric acid or sodium bicarbonate. The data for the curves in Figure 2 were obtained by adding increments of sodium bicarbonate to acidified egg powder which contained no sodium bicarbonate. The pronounced difference in the slopes of the 2 curves, especially in the important region near 1.5% sodium bicarbonate, explains the greater sensitivity of the method of determining pH after cooking. Similar curves were made with sample number 1 (Table 2) after adjusting the effective sodium bicarbonate concentration by the addition of various amounts of hydrochloric acid or sodium bicarbonate. That the 2 sets of curves were virtually superimposable was interpreted as establishing the validity of pH measurements made on modified commercial samples.

Effect of pH on palatability. Before the method of determining pH of cooked egg could be used as a control test, it was necessary to establish the pH range which describes the most desirable product. For flavor evaluation scrambled eggs were tested by consumer observers using the hedonic scale method *(4)*. Forty

TABLE 3

pH of dehydrated stabilized egg, uncooked and cooked

Sample	Condition	pH	
		Nominal sodium bicarbonate (percent)	
		0[a]	1.5[b]
3	Uncooked	5.4	6.8
	Cooked	5.7	7.4
4	Uncooked	6.1	7.3
	Cooked	6.5	8.7
5	Uncooked	7.1	7.7
	Cooked	—	9.7

[a] Commercial powder, modified by addition of standard hydrochloric acid solution.
[b] Commercial powder, unmodified.

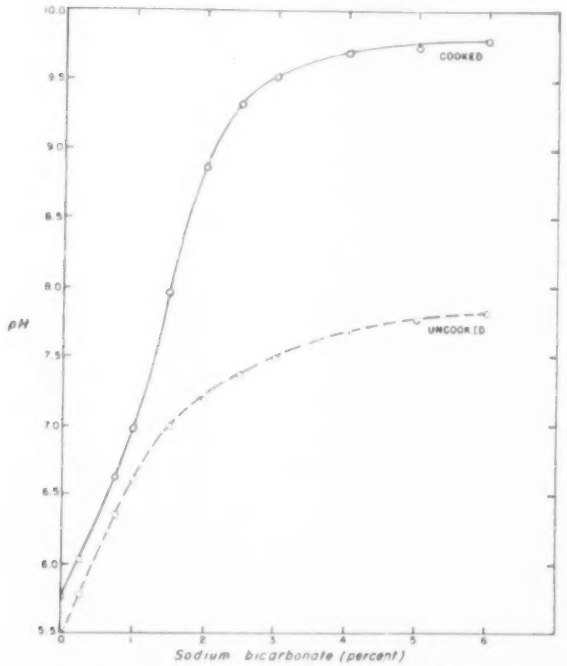

Figure 2. Effect of cooking on the pH of acidified egg powder reconstituted with sodium bicarbonate.

observers rated each sample on a 9-point scale ranging from *like extremely* to *dislike extremely*.

Acidified egg powder with 0, 1.5, 3.0, and 5.0% of added sodium bicarbonate was used. Inasmuch as milk is listed as an optional ingredient in Armed Forces recipes for scrambled eggs, one series of samples was reconstituted with water and evaporated milk, while water alone was used for a second series. In either case, there was a distinct preference for the samples containing 1.5 and 3.0% of sodium bicarbonate, with no statistical significance between mean ratings of these 2 levels (Figure 3). Without sodium bicarbonate, the scrambled eggs had a crumbly texture resembling that of cottage cheese. Those prepared with eggs containing more than 3.0% of sodium bicarbonate had a tough, rubbery texture. Egg powder containing 5.0% of sodium bicarbonate produced scrambled eggs by either recipe with a green discoloration, which had been found previously to be associated with an excess of sodium bicarbonate. The 3.0% sample containing milk had a normal color, but without milk the green color was slightly evident. The addition of milk was observed to lower the pH of cooked samples from 0.2 to as much as 0.8 of a pH unit. The inhibition of the green color by milk must be due, at least in part, to this lowering of the pH. The appearance of the green samples was described by many of the observers as unappetizing and moldy. The tasting and scoring of these green samples were done in a controlled test, but if they had been served under other circumstances it is possible that they would have been rejected entirely. In any case, it would seem advisable to avoid these off-colors by limiting the addition of sodium bicarbonate.

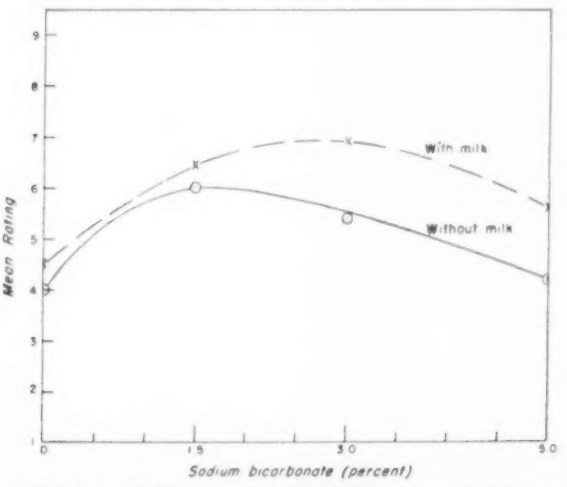

Figure 3. Effect of sodium bicarbonate concentration on consumer preference of scrambled eggs prepared with acidified egg powder.

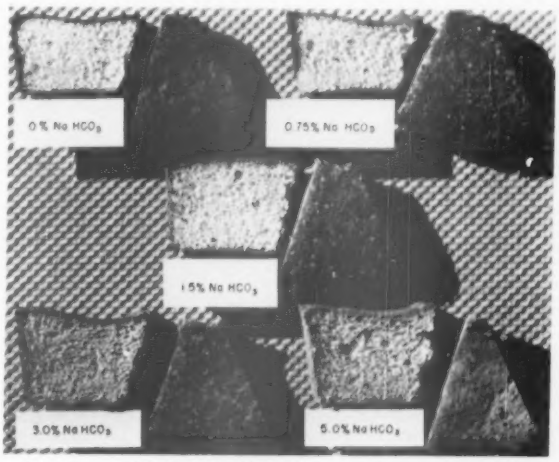

Figure 4. Effect of sodium bicarbonate concentration on volume, color, and grain of sponge cakes prepared with acidified egg powder.

Effect of pH on functional properties. Preparing sponge cakes proved to be the most convenient way to measure the functional quality of the egg powder. Acidified egg powders with 0, 0.75, 1.5, 3.0 and 5.0% of added sodium bicarbonate were used. In every test, the sample with 1.5% produced the cake of best flavor, texture and appearance (Figure 4). Egg powders with smaller amounts of sodium bicarbonate produced cakes with compact textures and with volumes reduced as much as 15%. When the egg powders contained larger amounts of sodium bicarbonate, the cakes showed coarse irregular cell structures and dark uneven colors. The color of these cakes was analyzed in the Hunter Color and Color-Difference Meter. As the amount of sodium bicarbonate in the egg powder was increased above 1.5%, the colors of the crumb changed from yellow to brown and were as much as 25% darker than normal. The crusts also acquired a definite off-color, which color-meter readings described as green. These cakes lacked the normal contrast between rich brown crust and bright yellow crumb.

The reaction between the hydrochloric acid and sodium bicarbonate of stabilized egg is similar to that of a baking powder in the sponge-cake formula. Upon inspection of Figure 4, the question arises as to whether the volume of the first cake was reduced by a damaging effect of the acid, or whether the volume of the third cake was greater than normal because of the presence of a pseudo baking powder. A control sample of unacidified powder made from the same egg pulp was not available for comparison. Therefore, sponge cakes were prepared with liquid egg as follows:

(a) Liquid egg control

(b) Liquid egg acidified with dilute hydrochloric acid to pH 5.5

(c) Liquid egg acidified with dilute hydrochloric acid to pH 5.5, then neutralized with an equivalent quantity of sodium bicarbonate.

The liquid contents of 12 shell eggs were blended together and three 216-gram portions were treated as indicated. The sodium bicarbonate was added to the third sample just prior to its use in the cake formula. The results of this experiment are illustrated in Figure 5. The volume of the cake prepared with acidified egg (number 2) was 24% below that of the control (number 1). The volume of the cake prepared with acidified and neutralized egg (number 3) was only 3% below that of the control. The results demonstrate a loss of leavening power in the presence of acid, and a restoration to the normal condition by the addition of an equivalent amount of sodium bicarbonate.

Tests with scrambled eggs and sponge cakes demonstrate the need for close control of the addition of sodium bicarbonate to acidified egg powder. The results of these tests were expressed in terms of pH by reference to the curves in Figure 2 and to similar curves prepared for other samples. It appears that a desirable range for the pH of cooked reconstituted samples is 7.0 to 9.0.

Effect of pH on color. The relationship between the pH and the color of cooked eggs has been mentioned. The formation of the green color apparently results from changes induced by heat in proteins of the yolk at high pH and involves a reaction between certain iron and sulfur compounds of the egg. It was produced in stabilized egg of normal pH by the addition of an iron salt, sulfur, sodium thiosulfate, or ferrous sulfide. Sulfhydryl sulfur added as cysteine did not produce the color. The reaction was completely inhibited by the addition of a small quantity of Versene (tetra sodium salt of ethylene diamine tetra acetic acid), a sequestrant for polyvalent metals. Tinkler and Soar *(6)* claimed that the greenish-black coloration which appears on the surface of the yolk of a hard-boiled egg is due to the interaction between iron in the yolk and sulfur from the white. It was observed in this laboratory, however, that yolk, washed free of white and made alkaline, turned green when cooked. It would appear, then, that there is enough sulfur and iron in the yolk to produce the green color, and that the only contribution of the white necessary to develop the color on the surface of the yolk of a boiled egg is the alkaline pH.

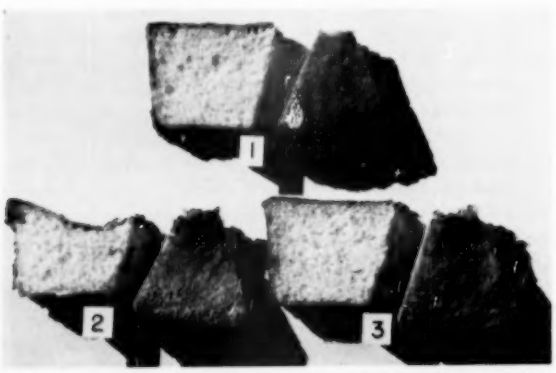

Figure 5. Sponge cakes prepared with fresh shell egg treated as follows: (1) control, (2) acidified to pH 5.5, (3) acidified to pH 5.5, then neutralized with sodium bicarbonate. pH values of batters: 7.8, 5.5 and 7.8, respectively.

SUMMARY

A method for determining the pH of dehydrated stabilized egg is proposed in which the pH measurement is made on the reconstituted sample after it has been cooked. The advantages of this method are that it is more sensitive to changes in acidity and alkalinity than when uncooked eggs are used and that it gives results which are reproducible and independent of the method of reconstitution.

Tests with scrambled eggs and sponge cakes demonstrate the desirability of close control of the addition of sodium bicarbonate to acidified egg powder. When the pH of the powder is too low there are flavor and texture defects and loss of aerating power; when it is too high there are flavor, texture and color defects. Furthermore, the purchase of excessive quantities of sodium bicarbonate at the price of dehydrated egg constitutes a loss to the buyer. A suitable range for the pH of cooked reconstituted samples is 7.0 to 9.0.

Under conditions of heat and high pH, a reaction is induced in either whole egg or egg yolk which results in the formation of a green color. The reaction, which can be inhibited by the addition of a metal-complexing agent, apparently involves iron and sulfur compounds from the egg proteins.

Acknowledgments

The writers acknowledge the help of the following members of this Institute: Patricia Conlin, for baking the sponge cakes; Catherine T. Walliker, for conducting taste tests on scrambled eggs; and Arthur T. Madura, for the photography work.

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The Influence of Vinegar Eels (Anguillula Aceti) on Vinegar Production[a,b]

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(Manuscript received June 5, 1953)

The effect of vinegar eels on acid production by Acetobacter aceti was studied in pilot-plant vinegar generators. Higher acid production and greater efficiencies of conversion were observed in those generators containing vinegar eels.

Studies on the nutritional factors affecting the production of acetic acid from dilute alcohol by *Acetobacter aceti* have led to the study of the effect of the presence of vinegar eels (*Anguillula aceti*) on the quick vinegar process. It has been observed that many industrial vinegar generators are infested with these eels, with no apparent detriment to the operation. However, most authorities on vinegar making have looked upon their presence as undesirable. They are generally removed from the finished vinegar by pasteurization and filtration.

Cruess *(3)* indicated that the vinegar eels destroy the acid and are very unpleasant in appearance, while Wyant *(12)* reported that they interfere with the acetic fermentation by destroying the film. Brannt *(2)* proposed that their part in the manufacture of vinegar is under all conditions an injurious one. That rain water used in vinegar making is generally the source of vinegar eels was suggested by Fabian *(4)*.

According to Zimmerman *(13)*, the adult vinegar eels normally feed on bacteria, both dead and living, rather than on substances dissolved in the environment. Peters *(8)* observed that the eels are microphagous, that they feed on bacterial cells and on mother-of-vinegar. Potts *(9)* in his work on growth studies of the vinegar eel demonstrated that they grew best when his solutions contained a dense bacterial growth, but grew very poorly when the bacterial growth was slight. Goodey *(5)* in his review on free-living nematodes indicated that it has been demonstrated and proved that they normally require microorganisms as a source of food. In discussing the bionomics of the vinegar eel, Wustenfeld *(11)* pointed out that the nutrition of the vinegar eel consists mainly of the organic constituents of the culture medium, which in vinegar production consists mainly of the acetic acid bacteria. He theorizes that the excreted products of metabolism may possibly serve the acetic acid bacteria once again as a source of nutrients, so that up to a certain degree we can speak of a mutual symbiotic supply system.

This work is a study of the effect of vinegar eels on the acetification process in quick vinegar type generators when *Acetobacter aceti* is the acid-forming organism.

METHODS AND PROCEDURE

A battery of 6 industrial pilot-plant vinegar generators was constructed, modeled after the one described by Hildebrandt *(6)* with minor modifications. This apparatus consists essentially of a series of glass cylinders filled with beechwood shavings, and a mechanism for continuous recirculation of the alcoholic solution during the period of operation. The generators were installed in a walk-in incubator room, which was maintained at a temperature of 30° C. (86° F.) ± 1° C. (30.2° C. to 33.8° C.). Airflow for each generator was controlled at 100 ml./min. and the rate of flow of circulating liquor was adjusted to 50 ml./min. to permit recirculation of the total volume (6000 ml.) every 2 hours.

With the exception of the first few experimental runs, when observations on the use of a natural medium—apple cider—were made, the circulating liquor was dilute solutions of industrial 35-A alcohol[c] to which various concentrations of mineral salts were added. The 35-A alcohol was refluxed for one hour to assure sterility, after which it was diluted with sterile distilled water to a concentration of 9% of alcohol by weight. The mineral salts used were all C.P. grade. They included potassium acetate as the source of potassium, phosphoric acid as the source of phosphorus, and ammonium chloride and sodium nitrate as sources of nitrogen. The solutions of these salts were sterilized by autoclaving, and were added aseptically in different amounts to the diluted distilled alcohol.

A pure culture of acetic acid bacteria isolated from a commercial vinegar generator in operation was used throughout this work. It was identified by its biochemical and cultural characteristics as *Acetobacter aceti*. The organism was inoculated into apple cider at the beginning of these experiments, and the liquor circulated through the system until a good growth of organisms developed on the packing of beechwood shavings. Samples from each generator were plated from time to time to check for contamination.

Vinegar eels were obtained from a commercial vinegar sample. They were cultured in cider vinegar containing a film of *Acetobacter aceti*, in which they multiplied rapidly. They were concentrated by centrifuging, washed several times in sterile distilled water, then held in a sterilizing solution[d] recommended by White *(10)*, after which they were washed and centrifuged several times in sterile distilled water. The eels were then inoculated into the distilled alcohol solution just before adding it to the generator. Tests for bacterial growth were made on the vinegar eels before and after they had been ground aseptically. No growth showed from the intact eels but water-clear droplet colonies grew from the ground-up eels after 7 days incubation at 30° C. (86° F.). Gram stains of these isolates showed gram-negative stubby coccoid forms and some elongated gram-negative rod forms. These isolates were later identified as *Acetobacter aceti*.

The generators were originally charged with 6 liters of alcoholic solution. After each test period of 8 to 18 days, 2 liters of the circulating solution were removed from each generator system and 2 liters of fresh alcoholic nutrient solution was added. At least 2 test periods were completed with each nutrient solution tested so as to permit adjustment of the organism to the new medium. At the completion of the tests on each

[a] Journal Article No. 1506, Michigan State College, East Lansing.

[b] Presented at the Thirteenth Annual Meeting of IFT, Boston, Massachusetts, June 23, 1953.

[c] 35-A alcohol is denatured alcohol prepared by the addition of 5 gal. of 85-88% ethyl acetate to 100 gal. of 190 proof alcohol.

[d] White's sterilizing solution: HgCl, 0.25 g.; NaCl 6.50 g.; Conc. HCl 1.25 ml.; ethyl alcohol 250 ml.; distilled water 750 ml.

nutrient the generators were drained and charged with 6 liters of dilute distilled alcohol. This was circulated through the generators for 4 hours and then drained off. After this washing procedure, a new nutrient solution was tested.

The acetification process was followed by measuring the increase of acid content and the reduction of alcohol content in the circulating solutions. Acid was titrated with 0.1667 N NaOH, using phenolphthalein as indicator. Alcohol was determined chemically by dichromate oxidation followed by titration of the residual dichromate with ferrous ammonium sulphate, according to the method discussed by Joslyn *(7)*. Efficiencies of operation were calculated from the ratio of the actual amount of acid produced to the theoretical yield expected from the decrease in alcohol content, as discussed by Allgeier *et al. (1)*.

RESULTS AND DISCUSSION

The first series of tests were conducted with fermented cider as the circulating liquor. The generator with vinegar eels produced 40% more acid at the end of 6 days than did the generator free of eels (Figure 1). The efficiencies of operation were of the same order.

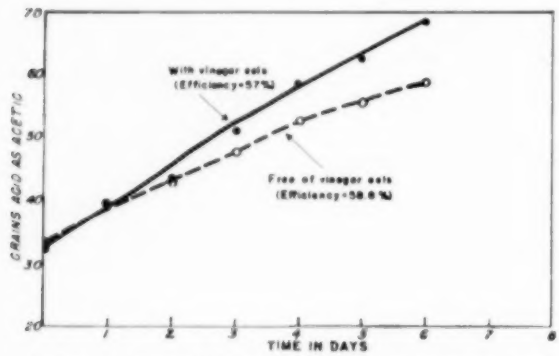

Figure 1. Effect of vinegar eels on the acetification of apple cider.

When dilute alcohol without added nutrients was the circulating liquor, there was no acid production in any of the 6 generators. When 0.01% potassium was added as potassium acetate to the dilute alcohol solution, the generator with the vinegar eels showed a slow but steady increase in acid production. While the increase in acid was initially more rapid in the generator free of eels the production leveled off in 4 to 5 days and was surpassed by the one with eels after 8 days (Figure 2). A slightly greater efficiency was apparent in the generator with the eels.

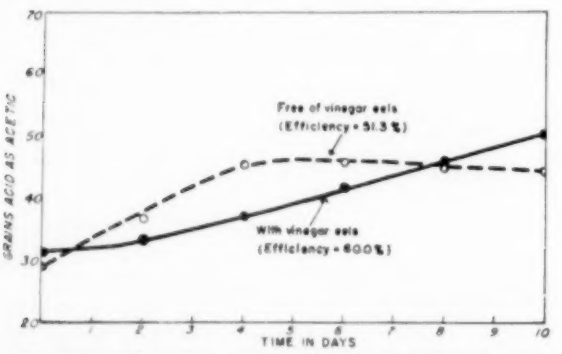

Figure 2. Effect of vinegar eels on the acetification of dilute alcohol containing 0.01% K from potassium acetate.

When 0.10% P_2O_5 was added as phosphoric acid to the dilute alcohol solution containing the 0.01% K, the influence of the vinegar eels was remarkably significant. The generator with the vinegar eels produced over 2½ times as much acid as the generator without the eels (Figure 3) and was about one-third more efficient.

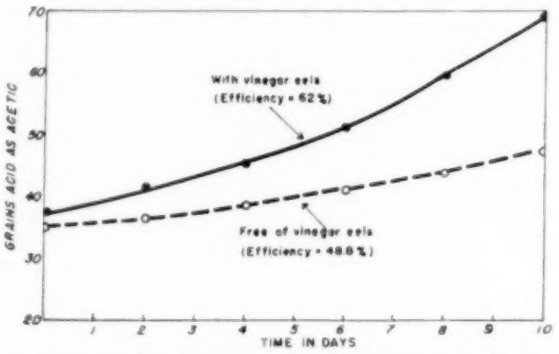

Figure 3. Effect of vinegar eels on the acetification of dilute alcohol containing 0.01% K from potassium acetate and 0.10% P_2O_5 from phosphoric acid.

Tests were also conducted using $NaNO_3$ as a sole source of nitrogen. Each of 3 generators with vinegar eels was compared with a generator free of eels containing $NaNO_3$ at the corresponding level, together with 0.01% K and 0.10% P_2O_5 as in the earlier tests. Thus 3 levels of N from $NaNO_3$ were tested simultaneously, 0.01% N, 0.05% N, and 0.10% N. Acid production

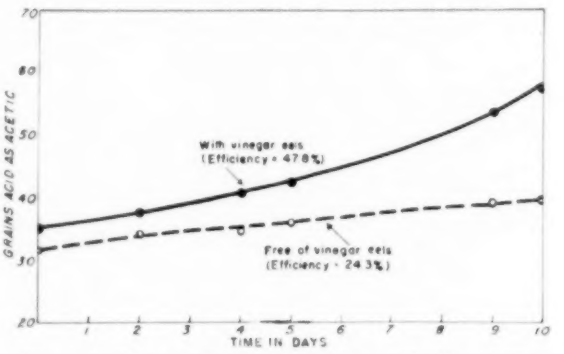

Figure 4. Effect of vinegar eels on the acetification of dilute alcohol containing 0.01% K from potassium acetate, 0.10% P_2O_5 from phosphoric acid, 0.05% N from ammonium chloride.

and efficiencies are indicated in Figure 5. In the generators free of vinegar eels, very little acid was produced, while in the corresponding generators with vinegar eels, acid was produced but at a comparatively slow rate. Additional tests conducted with $(NH_4)_2SO_4$ as a source of nitrogen showed good acid production both

The inclusion of 0.05% N in the form of NH_4Cl in the dilute alcohol solution containing the above mentioned levels of K and P decreased both acid production and efficiency of operation in each of the 2 generators. However, the generator with the vinegar eels produced much more acid (Figure 4) and was almost twice as efficient as the generator free of eels.

with and without vinegar eels. But as in earlier tests, acid production and efficiencies were higher with vinegar eels than without.

These preliminary observtions show that in the quick-vinegar type generators employed the presence of vinegar eels speeds up the acetification process and

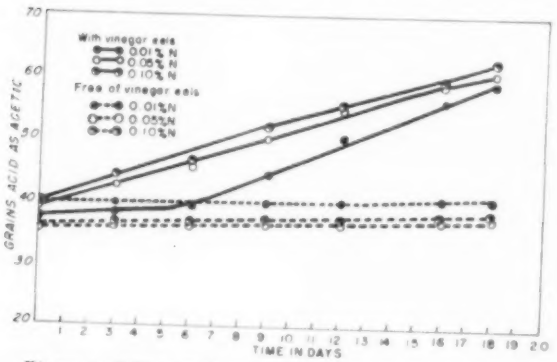

Figure 5. Effect of vinegar eels on the acetification of dilute alcohol containing 0.01% K from potassium acetate, 0.10% P_2O_5 from H_3PO_4, and three levels of N from $NaNO_3$.

increases its efficiency. The fact that vinegar eels in combination with inorganic phosphorus gave higher yields than the same medium without vinegar eels may mean conversion of inorganic phosphorus to organically combined phosphorus by the vinegar eels. Similarly, the higher acid production and higher efficiencies of operation observed when vinegar eels are in the medium with inorganic nitrogen indicates that there is some conversion of the nitrogen by the vinegar eels to a more readily available form.

It has been observed that in the generators with the eels, the beechwood shavings are bright and clean, whereas in the generators free of eels the shavings are covered with a dense accumulation of mother-of-vinegar. Microscopic studies of the organisms on these shavings show that the bacteria from the generators with the vinegar eels are short gram-negative rods, while those from the generators free of eels are mostly elongated gram-negative rods. It may be that part of the effect produced by the vinegar eels is due to their capacity to ingest bacterial cells and thus keep the generators free from the accumulation of old and dead bacteria that would clog the normal flow of circulating liquor through the interstices of the packing. Thus by the prevention of the formation of a dense zooglea of mother-of-vinegar, young vigorous bacteria with greater oxidative activity are able to carry on the conversion of alcohol to acetic acid more effectively.

Whether the vinegar eels act as "scavengers" or whether they synthesize or secrete some essential metabolite has not yet been established. Work on the nutritional requirements of the vinegar-bacteria in the acetification process is continuing; this paper is a preliminary report on the effect of the vinegar eels on the nutritional problem. Paired generators are being studied both with and without the presence of vinegar eels. The elucidation of the mineral requirements of the vinegar-bacteria may lead to a clarification of the mechanism by which the vinegar eels contribute to the acetification process.

SUMMARY

Presence of vinegar eels in the quick-vinegar process has been found to increase both the speed of acetification and the efficiency of the conversion of alcohol to acetic acid. These findings are not in agreement with observations reported by other workers. This effect was particularly evident when the dilute alcohol contained a source of phosphorus or of both phosphorus and nitrogen. The total acid produced was somewhat higher in the presence of eels than in their absence when only potassium was added. However, no pronounced effect of the vinegar eels was evident when dilute alcohol free of dissolved salts was used.

The mechanism by which the vinegar eels favorably affect the process has not yet been made clear. It may be that they serve a dual purpose. First, they act as scavengers keeping the beechwood shavings free of dead vinegar bacteria thus permitting live and active acetic acid bacteria to grow and thereby increasing acetification; second, the vinegar eels depend on the bacterial cells in the quick-vinegar generators as a source of food and convert some of the nutrient salts in the circulating medium to compounds more readily available to the vinegar bacteria. Thus there may be a symbiotic relationship established between the eels and the bacteria that is mutually beneficial.

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Relative Chemical, Functional, and Organoleptic Stabilities of Acidified and Glucose-Free Whole Egg Powders[a]

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(Manuscript received June 5, 1953)

Acidification, an empirical method of stabilizing whole egg powder, is shown to owe its effectiveness to the retarding effect of the increased acidity on glucose-induced phospholipid and protein deteriorations. Chemical measurements provide evidence, however, that inhibition of these Maillard-type reactions by acidification is incomplete, thus accounting for the markedly inferior stability of acidified as compared with glucose-free powder. Other problems, such as initial damage evident in acidified powders and greenish-black discoloration in scrambled eggs prepared from dehydrated powders, are discussed.

Acidification of whole-egg pulp to pH 5.5 prior to drying was proposed as a method of flavor stabilization by Boggs and Fevold in 1946 *(1)*. Previous investigators had demonstrated the value of acidification in retarding certain physical changes in dried eggs during storage *(2, 18)*, and Boggs and Fevold extended these results by showing favorable effects on flavor stability employing the device of carbonate or bicarbonate addition to neutralize the objectionable acid flavor. Their results were limited to those obtained with laboratory-prepared lyophilized powders and subsequently Conrad *et al. (5)* reported the successful adaptation of the procedure to spray-drying on a small scale. Further studies by the U. S. Quartermaster Food and Container Institute for the Armed Forces led to adoption of acidified powder for military procurement *(15)*.

Lightbody and Fevold in their comprehensive review of biochemical factors involved in whole-egg powder deterioration pointed out that there was no adequate explanation for the beneficial effects of acidificaton on flavor stability *(11)*. The retarding effects of acidity on condensations involving reducing sugars and proteins are well known and have been demonstrated in "dry systems" such as whole-egg powder *(2)*, dried egg white *(19)*, and model systems, e.g., glucose-casein *(13)*, and glucose-bovine serum albumin *(16)*. However, the results of Fevold *et al. (7)* appeared to rule out these reactions as important contributors to off-flavor development in whole-egg powder and intsead the available evidence pointed to the phospholipid constituents, in particular cephalin, as the site of off-flavor development *(3, 7)*. More recently Kline and co-workers showed that the most rapid reaction leading to cephalin degradation during storage of ordinary dried whole egg at elevated temperatures is glucose-induced *(11)* and further evidence was later presented identifying this glucose-cephalin interaction as a principal cause of off-flavor development *(12)*.

Since glucose removal before drying was shown to be feasible and to result in marked increase in flavor and functional stability *(12)*, it was considered advisable to re-examine the acidification process with regard to its effectiveness in retarding glucose-induced deteriorations, particularly the previously unrecognized glucose-cephalin interaction, and to compare the relative gross stabilities achieved by acidification and glucose removal.

EXPERIMENTAL METHODS

All whole-egg powders studied were prepared by spray-drying in commercial plants. In experiments where acidified and glucose-free powders were compared, they were prepared from portions of the same parent egg pulp and were processed (pasteurized, dried, and packaged) under conditions as nearly identical as possible. The procedures for preparing acidified and glucose-free (yeast) powders are described elsewhere *(10, 15)*, but some of the particular processing conditions observed are worthy of mention. In the acidification p ocedure, one part of C.P. hydrochloric acid was diluted with 5 parts of water and then added as a spray to the egg pulp which was continuously agitated until the desired pH of 5.5 to 5.6 was reached. Glucose-free powders were prepared by a resting-cell yeast fermentation consisting of adding 2 lbs. of fresh pressed bakers' yeast to each 1,000 lbs. of whole-egg pulp and holding at 85°-90° F. with minimum agitation until the pulp was sugar-free; this usually required about 2½ hours. Both types of pulp were pasteurized after the pretreatments. The particular pasteurization conditions used varied in the separate studies from 139-140° F. for 1½ minutes to 142° F. for 3 to 4 minutes. Immediately after drying, the cooled powders (80° F.) were packaged in tin cans which were filled, with tamping, with a weighed amount of powder which sufficed to fill the can to within one-half inch of the top. Either 350 g. of powder in a 401 x 411 (No. 2½) can or 1 lb. of powder in a 404 x 414 can was used. The cans were hermetically sealed and gas packed with either N_2 or a mixture of 80% N_2 and 20% CO_2. Random sampling of the cans for gas analyses immediately after packing showed that the residual O_2 in the "headspace" was less than 0.2% with the exception of a few obvious "leakers." The cans were kept at 0° F. or below until storage studies were initiated. Leakers detected after storage were discarded.

Most of the analytical procedures for estimating the extent of physical and chemical changes in the powders during storage

[a] Presented in part at the National Research Council Dehydrated Egg Symposium held in Chicago, Ill., Feb. 12-13, 1953.

[b] Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

[c] Those studies concerned with the preparation and storage of the 2% moisture powders were conducted cooperatively by the WRRL and QMF&CI. Views or conclusions contained in the portion of this report which refers to these cooperative studies are not to be construed as necessarily reflecting the views or endorsement of the Department of Defense.

[d] The Quartermaster Food and Container Institute for the Armed Forces is a branch of the Research and Development Division, Office of The Quartermaster General, Department of the Army.

have been reported previously, as have the organoleptic and baking tests *(11, 12)*. Determination of amino nitrogen content of the whole powder was made according to the Van Slyke manometric method on 1-ml. aliquots of suspensions containing 1 g. of powder in 40 ml. of 10% KCl and on filtrates prepared therefrom. The values obtained for 5, 10, 15, and 30-minute reaction times were plotted and extrapolated to zero time to cancel the linear rate due to interfering substances according to the method of Kekwick and Cannan *(9)*. Values obtained with the suspensions are reported as total amino-N and those with the filtrates as soluble amino-N.

Reflectance measurements were made with a Hardy automatic recording spectrophotometer. Percentage reflection of the sample as compared to a vitrolite standard was plotted by this instrument over the range of 400 mμ to 700 mμ and the particular values reported here are taken from these curves.

Conalbumin assays were based upon the ability of this protein, in the native state, to bind iron yielding a pink-colored complex *(1, 17)*. As applied to whole-egg powder, the method involved taking up the residues from soxhlet ether extraction in either 10% NaCl solution or in aqueous pH 7.6 buffer, filtering and plotting the difference in absorbancy of the filtrate at pH 5.5 (no color) and pH 7.6 (full color) over the range of 400 mμ to 600 mμ. A Coleman spectrophotometer was used for this purpose. Full color development at pH 7.6 was obtained using the conditions described by Fraenkel-Conrat and Feeney *(8)*. The difference curves obtained (cf. Figure 2) closely resembled those of the iron-conalbumin complex formed with pure conalbumin preparations.[*] (Figure 1). The slope of the linear

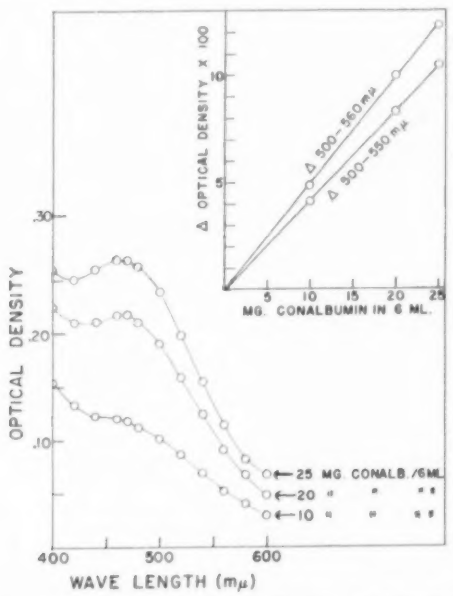

Figure 1. Assay method for conalbumin. Absorption curves for pure (>99%) conalbumin at graded levels in assay medium are shown. Plot in upper right corner illustrates proportionality of slope to conalbumin concentration.

ascending portion of these difference curves between 500 mμ and 550 mμ was used as a measure of the conalbumin concentration rather than the absorbancy at the absorption maximum (470 mμ) in order to eliminate difficulties caused by occasional turbidities. The method as applied to pure conalbumin preparations is illustrated in Figure 1. Since conalbumin loses its iron-binding capacity upon denaturation *(8)*, the method was appropriate for determining the effect of processing on the state of the conalbumin.

[*] Conalbumin samples judged to be at least 99% pure were supplied by Mr. E. D. Ducay of this Laboratory.

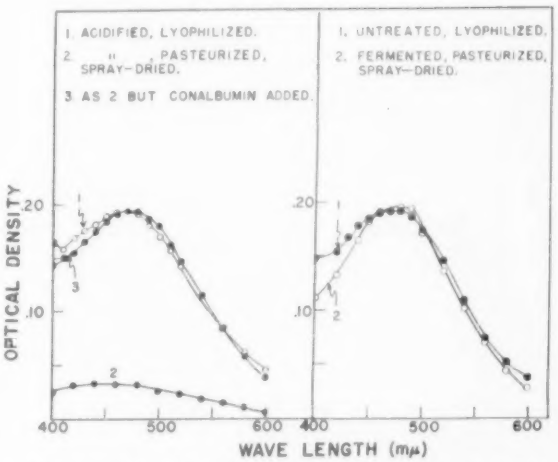

Figure 2. Effect of heat processing in denaturing the conalbumin in acidified whole-egg pulp. Pasteurization was at 142° F. for 3 minutes.

RESULTS AND DISCUSSION

Initial defects in acidified powder. Whereas acidified whole-egg powder is much superior in storage stability to ordinary powder, this improvement in stability is not achieved without encountering some defects. We have observed that scrambled eggs prepared from commercially processed acidified whole-egg powders usually exhibit considerable syneresis (water leakage), and possess a mealy or granular texture. Furthermore, they have a noticeable odor most frequently described as that of "wet feathers." Baking qualities are also slightly inferior (Tables 1 and 2). By comparison with comparably prepared standard or glucose-free powders, the acidified powders also show some suggestion of protein damage as indicated by significantly lower protein solubilities or soluble amino nitrogen values.

Recently we have identified a specific change that occurs during the commercial processing (pasteurization and spray-drying) of acidified whole-egg pulp (pH 5.5 to 5.6) which may account, in part, for some of the above-described defects. Conalbumin, a protein derived from the white, which represents about 7.5% of the total protein content of whole egg, is denatured in varying degrees, depending apparently upon the extent of pasteurization employed.

In Figure 2 are illustrated conalbumin assay curves for powders obtained in one experiment where the egg pulps were subjected to fairly severe pasteurization, 142° F. for 3 to 4 minutes. Processing was found to denature over 90% of the conalbumin in the acidified pulp; that contained in the yeast-fermented pulp appeared to be retained fully. This is readily seen by comparison with analyses of the lyophilized powders, prepared from aliquots of the same egg pulps, removed before pasteurization. That conalbumin activity was actually being measured by the method used was confirmed by showing that addition of pure conalbumin to the deficient processed acidified powder results in a curve which coincides with that for the lyophilized acidified powder (Figure 2).

In another experiment where the egg pulps were subjected to a milder pasteurization treatment, 139°-140° F. for 1½ minutes, a better retention of native conalbumin, amounting to about 45% of that obtained in lyophilized controls, was observed in acidified powder. Again, however, unacidified pulps processed in the same run, showed full retention of native conalbumin. This observation suggests that it is the pasteurization step at the lowered pH of 5.5, rather than spray-drying, which causes the conalbumin denaturation. Consistent with this view are the results of other analyses in this laboratory (WRRL) which have shown that egg white, not normally subjected to pasteurization, may be spray-dried over a pH range extending from 4.6 to 8.0 without denaturation of the conalbumin.

Relative effectiveness of acidification and glucose removal in retarding deterioration in 5% moisture powders (gas-packed). Acidified, glucose-free (yeast fermented), and standard (no pretreatment) whole-egg powders were prepared in a commercial plant from portions of the same parent egg pulp. The 3 portions were all pasteurized at 142° F. for 3 to 4 minutes and spray-dried in a Gray-Jensen dryer to 5% moisture (range of 4.9 to 5.2).

For the particular storage conditions under which the stabilities of these powders were compared, i.e., elevated temperatures and gas pack, the deteriorations leading to the appearance of off-flavors and loss in baking function have been shown previously to be largely glucose-induced and to occur in the phospholipid, cephalin, and in the protein constituents *(12)*. Consequently, the various physical and chemical tests reported here are concerned primarily with estimating the degree of change in these principal components. It may be useful to point out that whole-egg powder represents a nonenzymatic browning system in which the amino groups are in excess. Thus for each equivalent of reducing sugar there are, according to analyses in this laboratory (WRRL), approximately 4.4 equivalents of free amino groups, 3.7 of which are derived from the proteins and 0.7 from cephalin.

The relative stabilities of the 3 types of powder evaluated after storage for 5 weeks at 100° F. in N_2 are compared in Table 1. Regarding deterioration in the protein constituents, attention is directed to the measurements of protein solubility, salt-water-soluble fluorescence, and browning of the ether-extraction residue. It is apparent from a comparison of the relative increments in these measurements for the untreated and the glucose-free powders, that glucose-induced protein deterioration is the principal mechanism operative in the untreated powder. Acidification is observed to cause marked reduction in the extent of these changes, but it is clearly less than that accomplished by glucose removal.

Changes in the phospholipids are particularly significant, since they are correlated with off-flavor development *(12)*. The deterioration in these fractions was estimated from the increments in visible browning, ultraviolet absorption and fluorescence as determined by direct analyses on the phospholipid fractions isolated from control and stored powders (Table 1). The magnitude of these increments for the glucose-free powder are observed to be only about $\frac{1}{20}$th of those occurring in the untreated powder and it is clear that the phospholipid deterioration in the untreated powder is also almost entirely glucose-induced. Previously it has been shown that cephalin is the phospholipid involved *(11)*. Acidification is observed to reduce the extent of the glucose-induced phospholipid deterioration to about ⅓ of that occurring in the untreated powder. This, of course, offers a plausible explanation for the heretofore unexplained beneficial effect of acidification on flavor stability. However, it is again evident that acidification effects only a partial stabilization as compared to glucose removal.

TABLE 1
Relative stabilities of untreated, acidified and glucose-free powders containing 5 percent H_2O at 100° F. in N_2

Analysis	Time (weeks) at 100° F.	Untreated	Acidified	Glucose-free
Protein solubility, %	0	85	81	89
	5	60	73	85
Salt-water-soluble fluorescence, ϕ	0	1.6	1.4	1.4
	5	18.0	6.0	3.7
Browning in ether extraction residue, % reflectance at 450 mμ	0	58.6	62.8	58.6
	5	50.0	61.5	58.6
Phospholipid browning (10 mg./ml. ether), absorbancy at 500 mμ	0	0.02	0.01	0.02
	5	0.23	0.07	0.03
Phospholipid u.v. absorption (10 mg./ml. ether), absorbancy at 300 mμ	0	0.49	0.29	0.65
	5	2.02	1.02	0.69
Phospholipid fluorescence (0.1 mg./ml. ether), scale reading	0	3.7	2.2	3.4
	5	42.5	14.5	6.3
Glucose, % in powder	0	1.07	1.23	0.02
	5	0.06	0.25	
Total amino N, % in powder	0	0.41	0.41	0.41
	5	0.30	0.30	0.39
Browning of whole powder, % reflectance at 400 mμ	0	32.5	33.5	32.5
	5	22.0	29.5	32.0
Sponge cake volume, ml.	0	524	425	568
	5	172	246	408
Scrambled egg taste scores [1]	0	9.6	8.7	9.6
	5	2.8	6.3	7.4

[1] Difference required for significance at 5% level = 1.1.

An interesting effect of acidification is observed on examining the plots obtained by subtracting the absorption curve of the phospholipid fraction prepared from control powders (kept at −20° F.) from the curves for the phospholipid obtained from stored powders (Figure 3). This plot for the untreated powder shows a large increase over the entire range extending from the visible (browning) into the ultraviolet with a definite absorption maximum at 295 mμ and another indicated at about 340 to 350 mμ. The similar plot for the acidified powder illustrates the lesser increase in absorbancy over the entire range, but interestingly enough, acidification would appear to retard the formation of the component responsible for the 340-350 mμ maximum more so than the one at 295 mμ. This results in a sharper-appearing maximum at 295 mμ. Since, as seen from the plot, the formation of these components is essentially eliminated by the process of glucose removal, their elucidation has not been pursued.

Other analyses reported in Table 1 illustrate some of the gross changes measured on the whole powders. These were found to reflect generally the changes

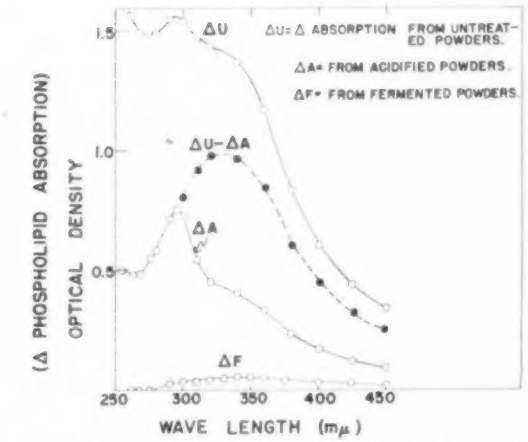

Figure 3. Relative effectiveness of acidification and glucose removal (fermentation) in inhibiting the increase in absorbancy of the phospholipid fraction occurring during the storage of whole-egg powders. Plots represent the difference in absorbancy of phospholipid from stored (5 weeks at 100° F.) and control (—20° F.) powders. Ten mg. phospholipid per ml. ether was used in all cases.

occurring in the protein and phospholipid constituents. Acidification did not appear to retard either glucose or amino nitrogen disappearance during storage at 100° F. and as previously noted by British investigators *(2)* also working at elevated temperatures, seemed to exert its influence by retarding the secondary changes of the browning process. However, this result may be fortuitous, as we have found that during storage of these same powders at 60° F., acidification markedly reduces the rate of both glucose and amino nitrogen disappearance.

Relative effectiveness of acidification and glucose removal in retarding deterioration in 2% moisture powders (gas-packed). Since whole-egg powders may be readily dried to 2% moisture in existing equipment, it was considered of practical interest to extend the comparisons of the 2 methods of stabilization to this lower moisture level. In an additional experiment glucose-free powder made by yeast fermentation and acidified powder made according to existing military procurement specifications *(15)* were prepared from the same parent whole-egg pulp under the joint supervision of representatives from the WRRL and QMF&CI. All batches of pulp were pasteurized at 139°-140° F. for 1½ minutes before drying in a Rogers-type spray dryer. The moisture content of the resulting acidified powders varied from 1.6 to 2.0% and that of the glucose-free powder from 2.0 to 2.2%. Storage studies included a comparison of the relative effectiveness of 100% N_2 pack *vs.* the 80% N_2 + 20% CO_2 pack presently specified for military procurement *(15)*. A few comparisons of the 2 powders at a higher (3.5%) moisture level are also included.

Table 2 compares the powders stored up to 6 months at 100° F. It is apparent that acidification does not prevent the glucose interactions with either cephalin or the proteins, as indicated by the marked increases in lipid and salt-water-soluble fluorescence that accompany the disappearance of both glucose and amino nitrogen in these powders. The combination of low moisture and acidification does, however, appear to be quite effective in retarding the secondary glucose-induced protein changes, as is evident from the excellent retention of both protein solubility and sponge-cake volume by the acidified powders.

Comparison of the phospholipid changes in the 2 types of powder as measured by the increases in fluorescence and ultraviolet absorption of the ether extracts shows very striking differences (Table 2). Obviously, the combination of acidification and low moisture does not prevent the glucose-cephalin reaction from proceeding at a fairly rapid rate during storage at 100° F. The elimination of this reaction in the glucose-free powders is reflected in their markedly superior flavor stability as evaluated in scrambled eggs by a trained taste panel (Table 2).

Trained panel measurements have been used in previous studies by us (WRRL) to measure only the degree of storage off-flavor. The inclusion of acidified powder was found to introduce difficulties due to the existence of initial off-flavors which could not be masked by varying the amount of bicarbonate added. Some judges were unable to distinguish consistently between storage and initial off-flavors in acidified powder. This was evident in the slightly lower taste score assigned the acidified control in the previous experiment with the 5% moisture powders (Table 1). In the present experiment this difficulty was obviated by giving the judges

TABLE 2

Relative stabilities of acidified and glucose-free powders containing 2 percent H_2O at 100° F.

Analysis	Time (mo.) at 100° F.	CO_2 plus N_2		N_2	
		Acidified	Glucose-free	Acidified	Glucose-free
Protein solubility, %	0	94	96	94	96
	1	92	96	93	94
	3	94	96	92	96
	6	81	91	81	93
Salt water soluble fluorescence, ϕ	0	1.2	1.3	1.2	1.3
	1	2.5	1.4	2.9	1.6
	3	6.6	2.0	6.8	2.0
	6	11.5	2.5	11.5	2.6
Ether soluble fluorescence, ϕ	0	0.6	1.0	0.6	1.0
	1	4.2	1.0	3.7	1.0
	3	10.7	1.6	10.2	1.6
	6	15.0	2.9	13.5	2.7
Absorbancy of ether extract at 300 mμ	0	0.23	0.32	0.23	0.32
	1	0.33	0.31	0.30	0.31
	3	0.61	0.31	0.55	0.31
	6	0.76	0.33	0.68	0.31
Glucose, % in powder	0	1.15	0.02	1.15	0.02
	1	0.74	0.01	0.71	0.01
	3	0.53	—	0.52	—
	6	0.39		0.39	
Total amino-N, % in powder	0	0.42	0.41	0.42	0.41
	6	0.35	0.39	0.33	0.42
Soluble amino-N, % in powder	0	0.39	0.42	0.39	0.42
	6	0.27	0.40	0.27	0.41
Browning of whole powder, % reflectance at 400 mμ	0	46.5	42.5	46.5	42.5
	6	34.5	41.5	34.5	41.5
Sponge cake volume, ml.	0	576	664	576	661
	3	582	634	609	611
	6	573	595	566	564
Scrambled egg Taste scores *	0	9.8	9.9	9.8	9.9
	1	7.3	9.7	5.4	9.7
	3	5.3	9.5	5.0	9.4
	6	2.4	7.7	2.6	9.1

* Differences required for significance at 1% level: 1.4 at 1 month; 1.4 at 3 months; 1.2 at 6 months

labelled controls (both acidified and glucose-free) at each tasting period, and the drop in score from 10 indicates the degree of difference of the coded samples from the labelled control. Controls were also submitted to the judges as coded samples and the high average scores assigned them (9.8 to 9.9) indicates the effectiveness of the method. With this procedure it is recognized that the scores are measures only of the degree of off-flavor developed during storage and do not represent preference or total off-flavor scores. So that the judges would not be influenced unfavorably by the browning of the acidified powders, the samples were served under sodium lights or in extreme cases the judges were actually blindfolded.

The trained panel results show that noticeable storage off-flavors appeared in the acidified powders after 1 month of storage at 100° F., while 6 months' storage elapsed before off-flavors could be detected in the glucose-free powders. The difference between the powders was so marked at 6 months that taste comparisons after further storage were not attempted.

On the basis of browning alone it would appear that the low-moisture acidified egg falls far short of having the shelf-life of one year at 100° F., which, according to information from the Quartermaster Food and Container Institute, is desirable for powder intended for use by the Armed Forces. Browning was noticeable in both acidified scrambles and sponge cakes after 3 months' storage and marked after 6 months (Figure 4), while the glucose-free powders showed no detectable browning even after 12 months at 100° F.

The powders were also compared at 70° F. for up to one year of storage and the results are shown in Table 3. As expected, both powders exhibited excellent stability at this temperature; however, the acidified powders showed slight deterioration after 6 months as evidenced by both increases in lipid fluorescence and slight, but significant, off-flavor development.

CO_2 packing vs. N_2 packing. Gas packing in a mixture of 80% N_2 and 20% CO_2 was first included in Quartermaster specifications for whole-egg powder in 1944. The same gas pack was carried over in the specifications issued for acidified powder in 1949. Boggs and Fevold in 1946 *(1)*, however, found no significant difference in the stability of acidified powder packed under N_2 or CO_2. In view of the well-known difficulties attending even partial CO_2 packing due to the rapid absorption of this gas by egg powder, it was considered worth while to re-examine the necessity for CO_2 in gas packing either acidified or glucose-free powder. The results of comparing the stabilities of these powders in 80% N_2 plus 20% CO_2 *vs.* 100% N_2 are included in Tables 2 and 3. With the possible exception of the trained panel scores for the acidified powder stored for 1 month at 100° F., no advantage could be detected for the CO_2-containing mixture over straight N_2 pack either in chemical stability, sponge cake performance, or trained taste panel comparisons. In view of these results, the use of 100% nitrogen, in those cases where gas packing is feasible, would certainly seem to be indicated.

TABLE 3
Relative stabilities of acidified and glucose-free powders containing 2 percent H_2O at 70° F.

Analysis	Time (mos.) at 70° F.	CO_2 plus N_2		N_2	
		Acidified	Glucose-free	Acidified	Glucose-free
Protein solubility, %	0	94	96	94	96
	6	92	96	92	95
	12	92	95	93	95
Salt-water soluble fluorescence, ϕ	0	1.2	1.3	1.2	1.3
	6	1.8	1.5	1.9	1.6
	12	2.2	1.2	2.0	1.2
Ether soluble fluorescence, ϕ	0	0.6	1.0	0.6	1.0
	6	2.6	1.7	2.4	1.8
	12	4.2	1.4	6.0	1.4
Glucose, % in powder	0	1.15	0.02	1.15	0.02
	6	0.94		0.93	
	12	0.79		0.80	
Sponge cake volume, ml.	0	576	664	576	661
	3	612	652	614	680
	12	512	617	517	613
Scrambled egg Taste scores [b]	0	9.8	9.9	9.8	9.9
	3	9.2	9.9	9.2	9.9
	6	8.6	9.9	7.3	9.9
	12	7.2	9.4	8.0	9.4

[b] Differences required for significance at 1% level: 0.4 at 3 months; 0.7 at 6 months; 0.8 at 12 months

Storage in air. The contribution of oxidative deterioration to off-flavor development during storage of egg powder at 100° F. has been shown previously to be of secondary importance to that of the nonenzymatic browning reactions *(12)* (this does not apply in the special case of so-called sugar-dried egg powder, i.e., powder containing about 30% sucrose). Some comparisons of the same 5% moisture powders discussed earlier (Table 1) were also made after storage in air for 5 weeks at 100° F. and the results indicate that acidification also does not appear to exert any particu-

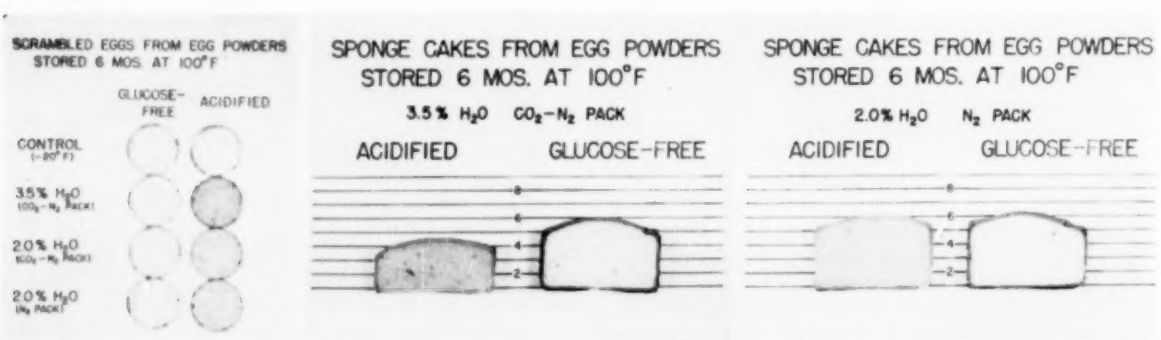

Figure 4. Browning evident in scrambled eggs and sponge cakes prepared from acidified powders after 6 months' storage at 100° F.

lar stabilizing effect on the oxidative type of flavor deterioration. The trained panel scores assigned the untreated, acidified, and glucose-free powders were 2.6, 3.3, and 5.1, respectively. The percentage of the headspace oxygen taken up by these 3 powders was 100, 60, and 49, respectively. Carotenoid loss as estimated spectrophotometrically *(6)* was apparently equal for each powder. In sugar-dried egg powder, where oxidative flavor deterioration is of principal importance, Conrad *et al. (5)* have reported that acidification actually caused a marked increase in the rate of flavor deterioration.

Green eggs. During the course of other concomitant studies with acidified and yeast-fermented glucose-free egg powders, we have observed that scrambled eggs prepared from some of these powders occasionally developed a marked greenish-black discoloration when kept on a steam bath (in covered petri dishes) for 20 to 45 minutes after the initial soft coagulation. It was found that occurrence of discoloration was correlated consistently with high pH achieved in these samples on cooking or holding on the steam bath (this pH was measured on the smooth paste prepared by macerating the cooled scrambled eggs with CO_2-free water). Thus scrambled eggs which developed obvious discoloration were found to be in the pH range of 8.6 to 9.1; below pH 8.6 discoloration was rare. Scrambled eggs prepared from fresh shell eggs do not represent a problem in this regard as the initial pH of 7.3 to 7.5 rises only to about 7.5 to 8.0 on cooking, according to Conrad *et al. (5)* or to about 8.3 in some of our own studies. It is obvious, however, that standard or yeast-fermented dried eggs having a reconstituted pH in the region of 8.6 to 9.0 before cooking are certainly going to be a problem with regard to "greening" where the intended usage may necessitate occasional holding on a steam table. The tremendous quantities of dried whole egg produced during World War II were all of the alkaline type, and it seems logical to assume that the many reports of "green eggs" were attributable to this phenomenon.

Acidified powders are also not free from the danger of "greening." Some of the "greenest" scrambled eggs we have observed have been made from such powders to which excess bicarbonate was added. The excess is converted to hydroxide during cooking with an attendant rise in pH. Thus in one case, an acidified powder with a reconstituted pH of 7.6 "greened" badly on cooking and holding and the macerated scrambled eggs were found to have a pH of 9.1.

A possible explanation for the greening phenomenon is indicated in the report of Tinkler and Soar over 30 years ago *(20)*. These workers presented evidence purporting to show that the greenish-black discoloration occurring on the outside of the yolk of a hard-boiled egg or in mixtures of yolk and white resulted from the development of alkaline conditions during cooking accompanied by the precipitation of black ferrous sulfide which against a yellow background gave rise to the type of discoloration observed. Whether the alkaline conditions were necessary for the liberation of free sulfide, or for the precipitation of iron sulfide, or both, was not elucidated. As is well known, the iron of whole egg is situated almost entirely in the yolk and it was presumed by these workers that the free sulfide originated from the white. Curiously, Tinkler and Soar could not obtain the discoloration in scrambled eggs prepared from dehydrated whole eggs.

Consistent with the conclusions of Tinkler and Soar we have found that the addition of a metal chelating agent such as regular Versene (tetrasodium salt of ethylene diamine tetraacetic acid) to an egg powder of pH 9 which, by itself, turned quite green, completely prevented the "greening" (0.1 g. of Versene was added with 30 g. of egg powder and 100 ml. of water; the pH was unchanged, remaining at 9).

A practical solution to the problem of discoloration is indicated from the pH findings above; powders whose "scrambles" do not achieve a pH of much over 8 should be prepared. We have found that yeast-fermented pulps may be slightly acidified with dilute hydrochloric acid before drying to yield a powder with a reconstituted pH of 7.0 to 7.5. Such powders do not have perceptible off-flavors nor do they require bicarbonate addition. The pH of scrambled eggs prepared from them has been determined to be between 7.2 and 7.8 and "greening" is entirely inhibited. Storage studies now in progress indicate that the stability of the pH 7 glucose-free powder is nearly identical with that of the previously tested pH 9 powders. Glucose-free powders prepared by use of glucose oxidase do not represent a problem with regard to discoloration, as they normally have a reconstituted pH of 6.9 to 7.2 as a result of gluconic acid formation.

SUMMARY AND CONCLUSIONS

Chemical analyses show clearly that the beneficial effect of acidification on stability of whole-egg powder is explainable in terms of the retarding effect of the increased acidity on both the glucose-protein and glucose-cephalin interactions. The inhibition of the latter reaction is particularly significant as it offers a plausible explanation for the heretofore unexplained beneficial effect of acidification on flavor stability. These analyses also show, however, that the inhibition of glucose-induced deteriorations by acidification is incomplete, even in powders of 2% moisture, and for obvious reasons, therefore, glucose removal before drying would appear to be a superior stabilization procedure. This view was borne out by the results of the various measures of stability used to compare the 2 powders including browning, off-flavor development, chemical and physical changes, and sponge-cake performance.

Conalbumin was found to be denatured in varying degrees during the commercial processing of acidified egg melange, apparently during the pasteurization step. This fact may account, in part, for the initial defects evident in acidified powder.

Inclusion of carbon dioxide in the gas pack, which is recognized to be superior to 100% nitrogen pack for stabilizing ordinary (no pretreatment) whole-egg powders, appears to offer no advantage over nitrogen for further stabilizing either acidified or glucose-free powder.

Studies on the greenish-black discoloration often observed in scrambled eggs prepared from either ordinary, acidified, or yeast-fermented glucose-free powders when these are held on a steam table for over 30 minutes disclose that this phenomenon occurs only when the pH rises to 8.6 or above during cooking and holding. The discoloration can be completely prevented even at pH 9 by the addition of a metal chelating agent such as Versene. This lends support to the proposal made over 30 years ago that the discoloration is due to the precipitation of black ferrous sulfide. The "greening" problem in glucose-free eggs prepared by yeast fermentation can be avoided by slightly acidifying the melange before drying to yield a powder having a reconstituted pH of 7.0 to 7.5. Such slightly acidified powders do not require bicarbonate addition nor is the quality significantly altered.

Acknowledgment

We are indebted to Joan E. Gegg and Kazuko Nishita for technical assistance throughout the course of the studies, to Marion C. Long for Kjeldahl and amino nitrogen determinations, and to Stanley Friedlander for absorbancy measurements. In particular we wish to mention our gratitude to the various volunteers from this Laboratory who gave generously of their time to serve on the trained taste panels.

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Preparation of Stable Frozen Puddings[a]

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(Manuscript received June 8, 1953)

Preparation of desserts of a cornstarch-pudding or soft-custard consistency that are stable to freezing and limited frozen storage is described. Elimination of the separation and curdled appearance of products prepared by the usual formulas is accomplished by substitution of waxy rice flour for part or all of the usual thickening agents.

Some of the most serious problems of the precooked frozen food industry have concerned maintenance of texture stability in foods containing cooked egg, starch, or flour. Since many highly acceptable low-cost desserts incorporate custards thickened with eggs and puddings thickened with common cereal starches, the development of successful methods for freezing these desserts would permit greater variety in the menu of complete frozen meals. The freezing of such desserts has not been practical because of the curdled appearance and liquid separation that occurs on thawing *(2, 3)*. Similarly, cakes containing fillings thickened with eggs and ordinary flour or starch cannot be successfully frozen because the liquid separating from such a filling soaks

[a] A report of work done under the Research and Marketing Act of 1946. The work was supervised by the Western Regional Research Laboratory, Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture.

into the surrounding cake *(5)*. The filling in cream pies thickened with egg and starch becomes grainy and shows liquid separation after being frozen and thawed *(3)*. The defect in these products is more obvious than in sauces and gravies, since in the latter products the curdled appearance and liquid separation are somewhat reduced during heating to serving temperature. Desserts, of course, must maintain their original appearance after thawing to refrigerator or room temperature.

Type of thickening agent was recently found to be the principal factor in the development of a curdled appearance and liquid separation in sauces and gravies subjected to freezing and frozen storage *(4)*. Use of a waxy rice flour containing only branched starch molecules was found to prevent the defect in these products for storage periods of approximately a year at 0° F. Differences in behavior between thickening agents from common and waxy cereals and also the differences among the various waxy cereals were attributed to the higher proportion of branched starch molecules in waxy cereals than in common cereals and to variations in molecular size and degree of branching of waxy cereal starches.

The discovery of the superiority of waxy rice flour for use as a thickening agent for frozen sauces and gravies suggested investigation of its usefulness in increasing texture stability of frozen pudding- and custard-type desserts. The work to be reported here shows the improvement in stability of some of these products resulting from incorporation of waxy rice flour in the formulas.

FORMULAS AND METHODS

Formulas and methods used for preparation of the desserts tested for stability to freezing and frozen storage are given in Table 1. The various proportions of ingredients used in the cornstarch-pudding type of desserts were those that produced desserts of a consistency similar to that of the cornstarch pudding. Likewise, the proportions used in the custard-type desserts were those that produced desserts of a consistency similar to that of the custards.

The products were sealed in 211 x 300 tin cans and frozen in an air blast at −10° F. (−23.5° C.) for 16 to 17 hours. They were transferred to storage rooms held at various temperatures. Prior to examination the puddings were thawed for 1 hour in a water bath at 77° F. (25° C.) and then held for 3 hours at a temperature of 35° F. (1.7° C.). They were examined visually for evidence of texture changes. Occasional tests were also made on products frozen at 0° F. in still air, but the products frozen under these conditions did not differ sufficiently in stability from those frozen at the lower temperature to warrant separate reporting of the results.

RESULTS AND DISCUSSION

Definite improvement in frozen storage stability of cornstarch-pudding and soft-custard types of desserts has been achieved through changes in the composition of the usual pudding and custard formulas (Table 2). The improvements are shown to be caused by inclusion of waxy rice flour in the formulas in place of cornstarch in the pudding and in place of part of the egg in the custard.

Freezing of cornstarch pudding made from a typical formula results in a large amount of liquid separation and an unattractive appearance on thawing (Figure 1). Substitution of waxy rice flour for cornstarch as the thickening agent and addition of gelatin to give a soft gel structure similar to that of a cornstarch pudding results in a product that retains its original appearance upon thawing after storage at 0° F. for 6 to 9 months (Figure 2). That the improvement is due primarily to the use of waxy rice flour as the thickening agent rather

TABLE 1

Ingredients and preparation methods for desserts

Ingredients	Cornstarch-pudding-type desserts				Custard-type desserts					
					Soft or baked		Soft			Baked
	Cornstarch pudding [b]	Cornstarch and gelatin pudding [b]	Waxy rice flour and gelatin pudding [b]	Waxy rice flour and gelatin chocolate pudding [b]	Egg yolk custard [c]	Whole egg custard [c]	Egg yolk and cornstarch pudding [d]	Egg yolk and waxy rice flour pudding [d]	Whole egg and waxy rice flour pudding [d]	Whole egg and starch or flour pudding [e]
	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾
Egg yolk or whole egg					11.8	15.0	6.0	6.0	8.0	15.0
Cornstarch	3.3	2.9					3.0			3.0
Waxy rice flour			3.9	3.2				3.0	3.0	3.0
Wheat flour or waxy cornstarch	—	—								3.0
Gelatin		0.4	0.45	0.4						
Milk	85.5	84.0	82.95	78.2	79.35	76.45	79.8	79.8	77.8	73.45
Water		1.5	1.5	1.5						
Sugar	10.4	10.4	10.4	9.8	8.2	7.9	10.4	10.4	10.4	7.9
Salt	0.15	0.15	0.15	0.15			0.15	0.15	0.15	
Vanilla	0.65	0.65	0.65	0.45	0.65	0.65	0.65	0.65	0.65	0.65
Chocolate				6.3						

[b] To prepare cornstarch pudding-type desserts, mix starch or flour, sugar, and salt. Add a small amount of cold milk and stir until smooth. Scald remaining milk 158-194° F. (70-90° C.) in steam-jacketed kettle, using steam at atmospheric pressure. Add the mixture of starch or flour, sugar, salt, and cold milk and cook 15 minutes, stirring constantly until mixture thickens and occasionally thereafter. Cool slightly, add vanilla, pour into containers and freeze.

In puddings where gelatin is used, soak the gelatin in the water. Add the moistened gelatin to other ingredients at the end of the cooking period. Stir until gelatin has dissolved.

For chocolate pudding, add the chocolate to the milk and melt during heating of the milk.

[c] To prepare custard, mix egg or egg yolk, sugar, milk, and vanilla. For soft custard, cook in top of double boiler with constant stirring until thickened; pour into containers, cool, and freeze. For baked custard, cook in cans surrounded by hot water in oven at 315° F. (157° C.) until completely coagulated; cool and freeze.

[d] To prepare soft custard-type puddings, mix a small amount of cold milk with the egg or egg yolk and a small amount with the dry ingredients. Heat remaining milk to 158° F. (70° C.). Add hot milk to the mixture of cold milk and dry ingredients and heat in double boiler with constant stirring for 10 minutes at a temperature of 185-203° F. (85-95° C.) in the mixture. Add hot mixture slowly with stirring to mixture of egg and cold milk.

For pudding containing egg yolk, cook in double boiler with constant stirring for 10 minutes at a custard temperature of 185-194° F. (85-90° C.). For pudding containing whole egg, cook in double boiler with constant stirring for 5 minutes at a temperature of 176-185° F. (80-85° C.). Fill cans, cool, seal, and freeze.

[e] To prepare baked custard-type puddings, follow procedure used in the first paragraph of footnote [d] (using either waxy rice flour, wheat flour or waxy cornstarch). Then reheat mixture in double boiler to 158° F. (70° C.). Pour into cans; cook in cans surrounded by hot water in oven at 315° F. (157° C.) until completely coagulated; cool, seal, and freeze.

TABLE 2

Maximum time that pudding and custard type desserts can be held in frozen storage without exhibiting visible texture change after thawing

Desserts	Stability of desserts stored at		
	—10° F.	0° F.	10° F.
Cornstarch pudding type desserts			
Cornstarch pudding	0	0	0
Cornstarch-gelatin pudding		less than 1 week	
Waxy rice flour-gelatin pudding	more than 14 months	6-9 months	less than 1 month
Waxy rice flour-gelatin chocolate pudding	more than 14 months	4-6 months	less than 1 month
Soft custard-type desserts			
Egg yolk or whole egg custard	0	0	0
Egg yolk-cornstarch pudding	0	0	0
Egg yolk-waxy rice flour pudding	—	2-4 months	—
Whole egg-waxy rice flour pudding	—	1-2 months	—
Baked custard-type desserts			
Egg yolk or whole egg custard	0	0	0
Whole egg-wheat flour, waxy cornstarch or waxy rice flour pudding	0	0	0

than to the addition of gelatin to the formula is shown by the very minor increase in stability that results from inclusion of gelatin in the formula containing cornstarch. Inclusion of chocolate in the formula containing waxy rice flour and gelatin decreases slightly the storage stability, presumably because of the starch content (8%) of the chocolate.

When stored at —10° F., both the plain and chocolate puddings containing waxy rice flour showed no visible change in appearance when thawed after 14 months. At a storage temperature of 10° F., however, retention of stability was limited to a storage period of less than one month.

Freezing of soft custards made from typical formulas containing either egg yolk or whole egg results in products having a curdled appearance after thawing. Replacing part of the egg with cornstarch does not improve the stability of these products to freezing. However, replacing part of the egg with waxy rice flour makes possible storage of the dessert containing egg yolk for approximately 2 to 4 months at 0° F. and of the dessert containing whole egg for approximately 1 to 2 months without visible change in the thawed product (Figure 3). The somewhat greater stability of the egg yolk than of the whole egg dessert was expected,

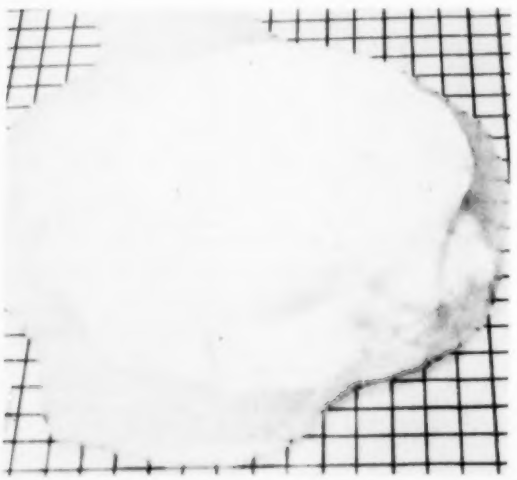

Figure 1. Cornstarch pudding thawed one day after freezing.

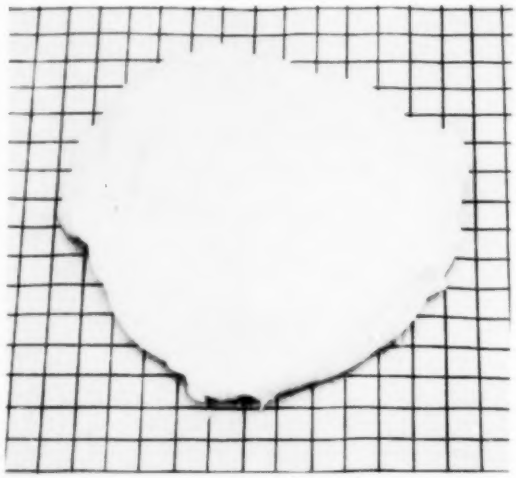

Figure 2. Waxy rice flour-gelatin pudding thawed after 9 months at 0° F.

since the white rather than the yolk exhibits damage when hard cooked eggs are subjected to freezing *(1, 6)*

Baked custards containing either whole egg or yolk that have been subjected to freezing exhibit a curdled appearance and considerable liquid separation on thawing (Figure 4). This damage was not prevented by

Figure 3. Egg yolk-waxy rice flour pudding thawed after 2 months at 0° F.

addition of thickening agents from either common or waxy cereals.

The methods developed for producing stable desserts of the pudding or soft-custard type can be readily applied to formulation of cake and cream puff fillings stable to freezing.

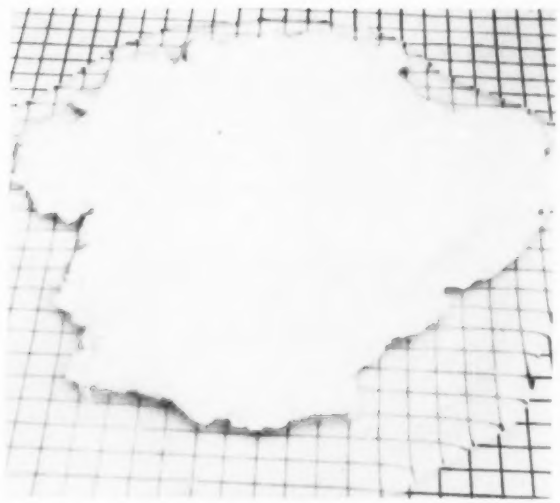

Figure 4. Baked custard thawed one day after freezing.

CONCLUSIONS

Desserts of a cornstarch-pudding or soft-custard consistency that are stable to freezing and limited frozen storage can be prepared by substitution of waxy rice flour for part or all of the usual thickening agents. The separation and curdled appearance of products prepared by the usual formulas can be prevented with waxy rice flour for 6 to 9 months for pudding-type desserts and from 2 to 4 months for custard-type desserts stored at 0° F.

Inclusion of chocolate in the pudding-type desserts decreases their storage life to 4 to 6 months; use of whole egg in place of egg yolk in the custard-type desserts decreases their storage life to one to 2 months. Waxy rice flour is not effective in frozen baked custards.

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Observations on the Canning of Pacific Coast or Dungeness Crabmeat[a]

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(Manuscript received June 5, 1953)

Four factors concerned in the canning of Dungeness crabmeat have been studied. These are shrinking, blueing, toughening and scorching or browning of the meat during and subsequent to the heat sterilization process. By suitably bleeding the live crabs, adequately cooking the raw crabs, thoroughly washing the cooked crabmeat, substituting sodium citrate for citric or other acids and water cooling the cans after the heat sterilization treatment, a canned product very much like freshly cooked crabmeat in color, texture and taste can be produced.

Pacific Coast or Dungeness (Market) Crab has been canned for quite some time along the entire Pacific Coast from California to Alaska *(1)*. The ideal aim or goal of the crabmeat canner may be stated to consist in so treating the meat that on removal from the can the product will be as similar as possible to freshly cooked crabmeat in color, texture, and flavor.

This goal has not been easy to achieve. A number of factors are involved which must be eliminated or largely minimized to produce an acceptable canned product. These are: (a) the shrinkage of the meat following the sterilization process, which is linked with (b) the toughening of the meat leading to a rubbery or brittle and stringy texture, (c) the blue discoloration which tends to develop in the meat after retorting, and (d) the brown discoloration or scorching of the white meat which sometimes results from certain retorting practices. A combined result of the interaction of these factors is that there often is such an alteration in the flavor and texture of the canned crabmeat that little resemblance to those of fresh crabmeat is evident. Even though the actions of some of these factors are interrelated and a treatment to overcome or minimize one may result in a beneficial or deleterious effect from others, nevertheless to facilitate this presentation they will be discussed separately in so far as is possible.

[a] Based on a paper presented at the Thirteenth Annual Meeting of the Institute of Food Technologists, June 21, 1953, Boston, Massachusetts.

CRITICAL FACTORS IN THE CANNING OPERATION

Shrinkage. Packers in California and elsewhere have sometimes encountered such a shrinkage of the meat during the sterilization process that an abnormally low drained weight results, based on presently accepted requirements. To illustrate this some data are given in Table 1 for commercially canned crabmeat from various sources. The rather wide variation in percent drained weight is evident. Some experiments were carried out on the effect of the cooking time for the raw crabs on the drained weight of the canned product. A representative experiment is given in Table 2. A commonly-used cooking time of 6 to 8 minutes is seen to be insufficient to adequately coagulate

the meat so that the subsequent effect of the heat sterilization process will not be significant. To obtain some information on the extent of water or salt solution imbibition by crabmeat, and to supplement the shrinkage data, some experiments were carried out on the uptake of fluid by crabmeat during immersion in water and various salt solutions. The results are summarized in Table 3. The distinction in behavior between raw and cooked

TABLE 1

Shrinkage in commercially canned crabmeat

Source of sample	Number of cans	Percent drained wt. of net weight
Washington	2	81.7
Oregon	3	86.7
California	20	76.5
Japan	1	84.9

TABLE 2

Effect of cooking time of raw crabs on shrinkage after canning

Minutes in boiling water	Percent drained wt. of fill-in wt.
7½	72.2
8	79.7
12	87.0
15	90.7
20	87.6

½ oz., or 15 ml., of 1% sodium citrate in 5% NaCl added to each can before closing.

TABLE 3

Uptake of fluid by crabmeat during 1-3 hour immersion in sodium chloride solutions

Percent salt solution	Percent gain in weight by				
	Raw	Cooked in tap water	Cooked in 3% NaCl sol.	Steamed	
				10 min.	15 min.
0 Dist. H_2O	13.8	8.0	10.4		
0 Tap H_2O	17.3	12.0	10.3	8.7	5.6
3	25.2	3.6	7.6	11.1	7.6
5	54.5	0	2.0	12.6	9.8
7	30.0	4.3	9.4	15.2	13.1
10	30.1	1.5	12.3	4.2	9.4

crabmeat is rather striking; as is also the effect of water and increasing concentrations of sodium chloride. From the data one may conclude that cooking the raw crabs in water and using a 5 percent sodium chloride solution to wash the cooked crab meat should lead to a minimal fluid uptake and therefore result in less water loss during the heat sterilization.

Blue discoloration, texture and flavor changes. The blueing of canned crabmeat has been of concern to packers on both coasts of the country. Numerous solutions have been proposed. These included the patented aluminum salts treatment of Fellers and Harris *(2)* for the Atlantic blue crab (Callinectes sapidus) and the bleeding by removing the end appendages by Elliott and Harvey *(1)* for the Pacific Coast or Dungeness Crab *(Cancer magister)*. Experiments in this laboratory to devise ways to prevent or minimize the blueing of Pacific Coast crabmeat after canning were begun in 1947. It was found that the copper-containing respiratory pigment of the blood, hemocyanin, was the agent responsible for the blueing. The more blood that is removed from the meat, the less the blueing that will occur. The blood remaining in the meat usually shows up as a curd-like material, at first white but later showing the greatest extent of blue discoloration. Besides, meat from portions of the crab with a poor blood circulation, such as the legs, claws and joints, often show a very marked blue discoloration because of the difficulty of contact of these parts with any washing medium. Even a thorough washing of the picked meat is not sufficient to wash out all the blood.

It was therefore reasoned that the removal of the blood would be facilitated if it could be carried out on the raw crabs before their being cooked—which operation, of course, effects coagulation of the blood. Furthermore, it was reasoned that the blood removal could be additionally increased by having the heart of the crabs assist by pumping out as much blood as possible from the inaccessible portions into the body cavity, whence it could be more easily removed. Accordingly, the bleeding of live crabs as easily and practicably as possible was studied. In Figure 1 is shown the dorsal surface of a male Dungeness crab. The heart is underneath and towards the bottom of the somewhat heart-shaped pattern near the rear end of the crab. It was found that a hole could be punched through the shell and the outlet from the heart with an ice pick, a sharpened nail attached to the head of a hammer or a similar instrument, in an area at the upper part of the aforementioned pattern. By this procedure the heart

Figure 1. Top view of a male Dungeness (or Pacific Coast) crab, showing pattern at lower portion below which the heart lies.

is not injured and continues to beat for five to ten minutes after the puncturing operation. The stuck crab still moves his legs and, when placed on his back with the ventral surface on top, the colorless to pale blue-grey blood can be seen running out of the hole, interspersed with intermittent jets coinciding with the heart beats. The movement of the legs assists the return of the blood from the sinuses in the extremities. In this manner an appreciable amount of blood (which turns blue on exposure to air) is obtained per crab, which otherwise would largely remain in the crabmeat. After an interval of approximately 10 minutes most movement of the crabs has stopped. The backs or carapaces are removed in one piece; the crabs are broken in half and cleaned free from viscera, gills and other extraneous anatomical residues. The cleaned halves are then well washed and cooked. This bleeding procedure helps to improve the color of canned crabmeat, as is seen from the results of an experimental pack in Table 4.

TABLE 4

Effect of bleeding live crabs on color of canned crabmeat

Treatment of live crabs	Blueing after canning
Crab halves cooked in water and rinsed	Definite throughout meat
Bled by puncture through shell above heart, halves washed well in tap water	Trace to none
Same, washed in 5% salt solution	Trace to none

The usual method, commercially employed, to minimize the blue discoloration is to rinse the picked meat in about a 1% solution of an acid such as citric, acetic, lactic, or tartaric. This presumably enables any copper present from remaining blood to combine with the acid to form a weakly or non-ionizing complex, which does not react as readily to form the blue color which becomes evident after retorting. This acid rinse ordinarily fulfills the purpose fairly well, and a product reasonably free from marked blueing can be prepared. However, the acid treatment brings about a more extensive coagulation or denaturation of the meat proteins with the result that the crabmeat usually

found in commercial packs often is rubbery or brittle and stringy with little resemblance to the texture or flavor of fresh cooked crabmeat. Furthermore, the acid rinse followed by the heat treatment of the canned meat increases the shrinkage above that caused by the retorting alone.

To eliminate or minimize the above rather undesirable changes in the acid-treated meat, a study was made in an attempt to retain the apparently beneficial action of the citrate ion without introducing the deleterious effect of the acid. This was accomplished by using sodium citrate instead of citric acid, as is seen in the data of Table 5. In this experiment commercially

TABLE 5
Effects of citric acid and sodium citrate on quality of canned crabmeat

Treatment of commercially picked crabmeat	Quality of canned crabmeat				pH after canning
	Blueing	Texture	Taste	% shrinkage	
Tap water wash	definite	fairly good	fairly good	22.5	7.0
0.5% citric acid wash	slight but evident	rubbery	not very crablike	30.0	5.9
1% citric acid wash	very slight	tough and stringy	not crab-like	33.7	5.8
Same followed by tap water rinse	slight but evident	rubbery	flat	30.0	6.1
1% sodium citrate in 5% NaCl wash	trace	good—like fresh crab	good—like fresh crab	17.3	6.7

prepared crabmeat without any acid treatment was the raw material. The marked improvement in texture and flavor of the canned product by using sodium citrate rather than citric acid is evident. The canned crabmeat washed with sodium citrate solution was very similar, particularly in texture and flavor, to fresh cooked crab meat.

Similar results were obtained by using citric acid solutions partially neutralized with disodium phosphate and lemon juice dilutions buffered with phosphate to a pH range of 6.5 to 6.7. There was also a marked improvement in texture and flavor of canned crabmeat treated with these mixtures. The lemon juice added another flavor component which in low concentrations was quite pleasant. Concentrations of lemon juice above 2 to 3% imparted a marked lemon flavor which tended to mask that of the crabmeat itself.

Brown discoloration or scorch. The least serious of the factors influencing canned crabmeat is the browning of the white meat, often referred to as scorching. This is largely the result of a faulty retorting practice, as shown by the data of Table 6.

TABLE 6
Effect of retorting process on browning of commercially canned crabmeat

Retorting procedure	Cooling of cans	Browning
145 min. at 220° F.	water	none
90 min. at 230° F.	water	none
60 min. at 240° F.	water	none
40 min. at 250° F.	water	none
35 min. at 250° F.	air	definite

A definite brown discoloration was only found when the cans were removed from the retort while still hot and allowed to cool in the air. A prompt water-cooling of the cans in the retort following the heat process will yield a product with no significant browning of the crabmeat.

DISCUSSION

Canning crabmeat is a complex operation in the course of which a number of changes may occur leading to a detraction from the value of the final product. In the preceding section no emphasis was placed on the importance of using only actively alive crabs for canning. A number of deleterious changes of the meat commence when crabs are near or after death. Among these is a darkening of the meat by the action of tyrosinase (3). It is therefore imperative for maximum quality of the canned product to use only actively alive crabs.

Using sufficiently cooked crabmeat, an adequate preshrinkage of the meat will have occurred before it is put into the can. The use of a 5% sodium chloride solution for all washing operations rather than plain water appears to be advisable from the data on the uptake of fluid by crabmeat. The addition of 1% sodium citrate to this salt solution would further increase its effectiveness by tending to overcome the deleterious effect of the presence of blood not previously removed from the meat. The tendency of the canned crabmeat to become alkaline through the liberation of volatile nitrogen compounds during a lengthy storage period could be decreased or slowed by additionally buffering the sodium citrate—sodium chloride solution about pH 6.5. As an added precaution against the development of the blue discoloration in the can during storage, the addition of a small amount of 1% sodium citrate in 5% sodium chloride solution to each can before closing is suggested.

Combining all the above information the following processing procedure for canning crabmeat is suggested:

a. Bleed actively live crabs by puncture above heart through the shell, using the pattern at the lower end of the top of the crab as a guide. Place stuck crabs on their backs for about 10 minutes.
b. Soak the cleaned halves in a 1% sodium citrate in 5% sodium chloride solution for at least 10 minutes.
3. Cook crab halves 15 minutes in water, using fresh water for each batch.
d. Wash cooked halves thoroughly in the above sodium citrate—sodium chloride solution.
e. After picking, thoroughly wash meat in a fresh 1% sodium citrate—5% sodium chloride solution.
f. After filling can with meat, add ½ oz. of 1% sodium citrate in 5% sodium chloride solution.
g. Retort ½ lb. cans 60 minutes at 240° F., or 50 minutes at 250° F., followed by an adequate water-cooling period.

In the above-outlined procedure there is a marked emphasis on thorough washing in the presence of sodium citrate—sodium chloride, since this constitutes the chief means of removing retained blood and decreasing the incidence of blue discoloration in the canned product. This treatment also avoids the alterations in texture and flavor usually found in canned crabmeat treated with acid. With the procedure outlined good experimental crab packs have been prepared in the laboratory and in canneries. One canner prepared a regular commercial pack of crab using the recommended method and this was very favorably received by the trade channels; it even received a premium in price over the then currently available packs of crabmeat.

In the canning of crabmeat, even with the aforementioned suggestions, all contact of the crabs with iron or copper surfaces should be carefully avoided. Metals for handling and storing crabmeat should be made of stainless steel, monel metal, or aluminum. This includes

such pieces of equipment as table tops, cooking and washing vats, shell-cracking utensils, receptacles for storing crabmeat, and colanders used in washing the meat.

SUMMARY

Various factors which influence the quality of canned crabmeat have been studied and a means to minimize or eliminate them have been determined. These included shrinkage after retorting, development of a blue discoloration, alteration of the texture and flavor and brown discoloration or scorch. A procedure for largely overcoming these effects is outlined.

Acknowledgment

The author wishes to express his thanks and appreciation to Mr. Willard E. Baier, California Fruit Growers Exchange, Ontario, California, for making available the canned lemon juice used in some of the experiments and accumulated information on the use of lemon juice in shellfish utilization.

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Notes and Letters

Modification of the Pre-Ashing Apparatus for Preparing Sirups and Other Highly Foaming Products

Since previously reported *(1)*, the pre-asher apparatus has been successfully used in the pre-ashing of highly foaming and sugar containing substances *(2)*. During this period of time, a series of improvements (Figure 1) have been made in the original apparatus.

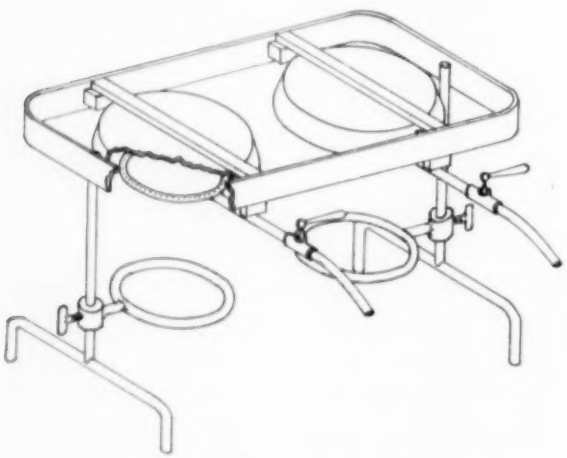


Figure 1. Pre-ashing apparatus.

The principle by which the pre-asher functions (heat reflected downward) has not been altered in the least. The modifications made in the apparatus are: The body of the pre-asher apparatus now consists of an upper frame and supporting legs. The upper frame is made of $\frac{1}{8}$ in. by 1 in. flat steel bar stock formed into an open frame 7 in. wide by 12 in. long. The frame is supported on each end by $\frac{3}{8}$ in. round steel rods 5 in. long welded to the upper frame. The other end of the rod is welded to a U-shaped piece, also made of $\frac{3}{8}$ in. rod.

It has been found that heat-reflecting dishes made of thin gage aluminum burn through rather quickly. These were replaced by 2 new types which are proving very satisfactory. One type is a cast aluminum dish with a varying cross section about $\frac{1}{8}$ in. thick at the edges and about $\frac{3}{8}$ in. thick at the base where the heat is concentrated. Another type is made of stainless steel of constant thickness ($\frac{1}{8}$ in.), of truncated cone or pie pan shape. The large diameter is 5 in. and the smaller diameter is $4\frac{3}{4}$ in. The inside depth is $\frac{3}{4}$ in.

Each reflecting dish is attached to a support bar $6\frac{3}{4}$ in. long by $\frac{1}{2}$ in. wide by $\frac{1}{8}$ in. thick. In use, these bars rest on metal lugs $\frac{1}{4}$ in. by $\frac{1}{4}$ in. by $\frac{1}{2}$ in. which are welded to the upper frame of the pre-ashing apparatus. This construction facilitates the placing and removal of the reflecting dishes.

The ring burner holders are welded to the upper frame of the apparatus in line with the support lugs.

Support rings for holding the dishes containing the sample to be pre-ashed are mounted on the legs of the apparatus.

It has been found to be advantageous to place a piece of asbestos board across the top of the upper frame when the apparatus is in use to keep heat from radiating upward.

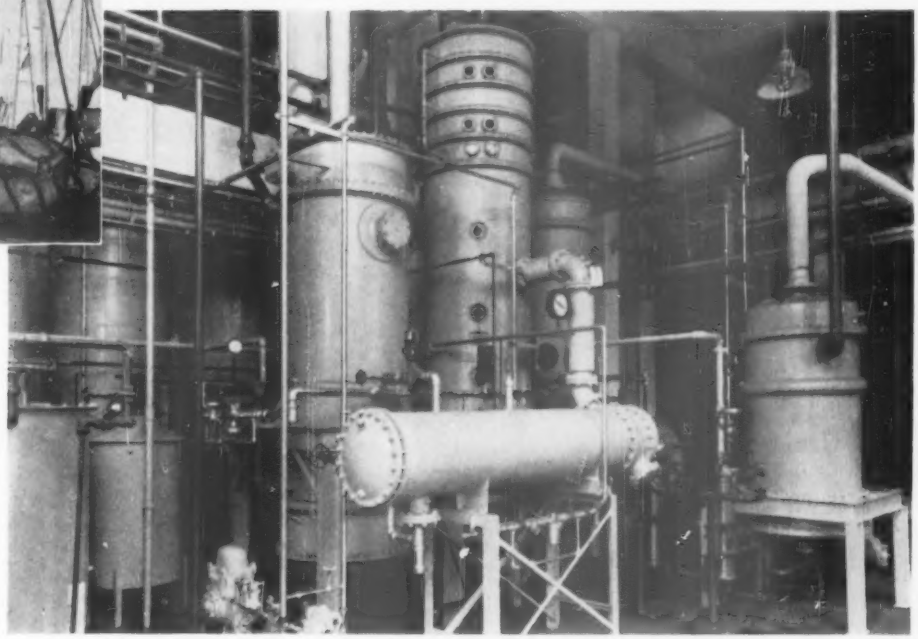
Silvio Crespo
D. C. Lewis
American Stores Co.
Bakery Division Laboratory
Philadelphia, Pa.

July 27, 1953.

LITERATURE CITED

1. Crespo, Silvio. *Anal. Chem.*, **24**, 921 (1952).
2. *Ibid.* Food Technol., **10**, 394-395 (1952).

Spice Shipments are not always the same...



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Books

T. Wallace and R. W. Marsh (editors). SCIENCE AND FRUIT (Commemorating the jubilee of the Long Ashton Research Station, 1903-1953). University of Bristol, Bristol, England, xiii + 1-308 + 31 plates, $4.50 (30 shillings).

The Long Ashton Research Station, which celebrated its jubilee recently (see *Nature, 172, 273-274*, August 15, 1953), the second oldest agricultural research station in Britain, began as the privately founded National Fruit and Cider Institute. It has become a widely recognized center for the scientific investigation not only of cider (our fermented apple juice or so-called "hard" cider) but also of unfermented fruit juices, syrups, concentrates and fruit pulps. In addition to investigations on the utilization of fruit, the factors influencing growth and fruiting habits of fruit trees and quality of fruit produced, fruit breeding, the nutrition of fruit and vegetable crops, the control of insect pests and diseases, and home and farm preservation of fruit and vegetables were and are being studied at the station.

The activities of the Long Ashton Research Station are interestingly and authoritatively described in a series of twenty-two documented articles by present and former members of the Station and others. These include the introduction devoted to the origin and development of the station, four articles on cider and one on fruit juices and other fruit products (apple juice, soft fruit juices and syrups, soft fruit squashes, fruit wines, black currant syrup, rosehip syrup, carrot juice concentrate and carrot pomace, plum purees and powders, fruit juice concentrates), six articles on various aspects of fruit culture, three on plant nutrition, six on plant pathology, and one on domestic food preservation. The volume includes a record of the scientific and administrative staff, a foreword by Sir Winston Churchill, a preface by Captain D. M. Wills, and Lord Rothschild's jubilee lecture on agricultural research. The latter is an excellent survey of the problems of the organization of agricultural research in Britain as seen by the chairman of the Agricultural Research Council.

Long Ashton Research Station had its origin in a scheme for experiments on cider-making started in 1893 and continued until 1903 by Mr. R. N. Grenville privately until the establishment of the National Fruit and Cider Institute in 1903. This became associated with the University of Bristol as one of a series of Agricultural Research Institutes in 1909. In 1918 following World War I the British Food Production Department provided a center for research in domestic fruit and vegetable preservation at Campden. By 1927 commercial canning became established in Britain and the Campden Research Station devoted an increasingly large part of its work to the problems facing the new industry. In 1930 the domestic aspect of fruit and vegetable preservation was transferred to the Long Ashton Research Station while Campden remained the center for industrial canning research. The annual reports of these two University of Bristol research stations, the Agricultural and Horticultural Research Station at Long Ashton, and the Fruit and Vegetable Preservation Research Station at Campden, and the scientific and technical publications of their staffs, have long been most useful sources of research on the cultural and utilization aspects of fruit and vegetable crops. The present volume is a most useful summary of the developments made by the staff at Long Ashton during the past fifty years and also traces the evolution of agricultural research from the early systematic testing of varieties of apples and pears to select those most suitable to the manufacture of cider and perry and investigation and demonstration of the best methods of utilizing these in the production of cider, perry and related products, to the widespread basic investigation of problems in the fields of plant pathology, plant biochemistry and plant physiology. Applied research, particularly on short term problems, and the close contact and cooperation with industry which existed originally was largely abandoned. It is interesting that Lord Rothschild selected these among the four aspects of the present agricultural research program in Britain that he criticized.

The pattern of developments in agricultural and horticultural research at Long Ashton has been closely paralleled in the State Agricultural Experiment Stations here. Applied research on short time horticultural projects and problems that the farmer was not able to carry out himself and the development of methods of utilization of crops leading to improved processing and new products occupied the attention of the staff. Later these were supplanted by more basic investigations of various aspects of food production, preservation, distribution and utilization. At first information available from physical and biological sciences was applied and later field and industry observations were used to direct research in basic fields. The steady progress and expansion of Long Ashton, the changing horizons in objectives and methodology and the recognized scientific and technical contributions of the research staff make this volume an important contribution to the history of agricultural research and its administration.

The present status of British cider-making, a highly organized industry, in comparison with its modest beginnings is due largely to the ability of the staff at Long Ashton to analyze clearly the relation of fruit quality to suitability for cider making and to control the fermentation and prevent bacterial and other disorders so common fifty years ago. In the related field of pomology much progress was made in the study of factors controlling vegetable growth, fruiting character, quality, and mineral metabolism and nutrition. The investigations on the control of insect pests and plant diseases, by insecticides, pesticides, and fungicides have been directed to the chemical standardization of insecticides and fungicides, to the development of better methods of application and to basic insecticidal and fungicidal studies.

The historical development and present status of research on the various phases investigated at Long Ashton is clearly presented but the references cited are largely to publications of the staff and it is difficult for those who are not particularly informed to assess properly the contributions made by the staff in relation to existing knowledge in the fields surveyed. This

(Continued on page 32)

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BOOKS

(Continued from page 30)

difficulty is rendered greater by the lack of subject index which would have facilitated the use of the material presented. The data presented on the varietal and environmental factors which influence the chemical composition of apple juice and the vintage quality of cider are not too impressive nor is the suggestion that the probable quality of the resulting cider can be obtained from measurements of rate of fermentation of the juice. The existing British commercial practice of fermenting apple juice by the naturally occurring microflora (also true in France) compares unfavorably with the Swiss and German practice of using selected yeasts and fermenting the cider under controlled conditions. Sulfur dioxide was not used in the control of fermentation even experimentally until the 1951-52 season, which is most interesting to enologists. The bacterial disorders of cider were investigated in some detail but still remain to be completely elucidated.

In the field of fruit culture, the contributions of the Long Ashton group to the factors governing fruit-bud formation have been most thorough, the horticultural application of plant hormones has followed largely the pioneering work carried out in the United States, the work on nutrition of fruit-trees was based on survey of soils in fruit orchards and on soil-plant inter-relations as has long been accepted, orchard factors (those inherent to the trees and those external to the trees) influencing quality and storage diseases were investigated in detail but few fundamental contributions were made to post harvest physiology or to the physiological storage characteristics, and the extensive fruit breeding experiments carried out were largely in the field of applied rather than fundamental genetics. More fundamental were the investigations in plant nutrition which included the use of sand-culture methods, to determine the nutritional requirements of fruit plants, particularly as regards the micro-nutrient minerals; mineral nutrition of fungi; and more recently the applications of chromatographic methods to the study of biochemistry and nutrition of plants. In the field of plant pathology, the investigations at Long Ashton included the biology of insect pests attacking apples, the biology of apple and pear scab caused by Venturia, and on insecticides and fungicides. The investigations on sprays and spraying machines have been particularly thorough.

As a record of the developments during the past fifty years in the application of science to fruit growing and utilization, the selection of projects for investigation and the accomplishments that have been made in the solution of the problems selected for investigation this volume is a most important contribution.

M. A. Joslyn
Berkeley, California

Into the Freezer—and Out, by Donald K. Tressler, Clifford F. Evers, and Barbara Hutchings Evers. 2nd edition, 246 pages, illustrated, 1953. The Avi Publishing Co., Inc., New York, N. Y. Price $3.75.

This second edition is much more intriguing (though not more sound and accurate technically) than the first edition, because it takes the foods not only out of the freezer but into numerous appetizing prepared dishes ready to be served on the table. Here the new illustrations serve the purpose of stimulating the appetite and the imagination. Thus the book becomes a guide to living with a freezer cabinet or frozen-food locker or both, or with frozen foods purchased and held in a freezer compartment of a refrigerator. With ample freezing equipment, the householder is tempted to undertake various provisioning enterprises, such as hunting, fishing, gardening, and relieving the market when temporarily glutted with fruit, vegetables, poultry and what not. The range of subjects treated is impressive. There are chapters on purchase of a cabinet, operation of a locker plant, management of freezer space throughout the year—with sufficient detail to develop the reader's acumen in such matters and make him a good "conversational refrigerationist" as well as a practical success. Further, one can learn much here about nutritive qualities of frozen foods, of frozen-food research and its achievements and current problems, and from perusal of additional chapters she and he can plan complete menus for year-round use—including juices, purees, meats, fish, shellfish, poultry, eggs, ice creams and sherbets, baked goods, native and exotic delicacies, left-overs, hors d'oeuvres.

The first edition, by the two first-named authors, was published in 1951 and is now out of print. The third-named author, Barbara Hutchings Evers, is responsible for the new matter on preparation, cooking, and serving and has brought to her task an enviable background of experience as a professional home economist.

H. C. Diehl
Colorado Springs, Colorado

Food Science Abstracts is published bi-monthly, with an Annual Index, by the Department of Scientific and Industrial Research of Great Britain. Within the Department the Director of Food Investigation is Dr. Franklin Kidd, 20A Regent St., Cambridge. The Abstracts can be purchased from Her Majesty's Stationery Office at various addresses in the British Isles (one of which is York House, Kingsway, London WC2) and in the United States from British Information Services, 30 Rockefeller Plaza, New York 20, N. Y. An annual subscription, including Annual Index and postage, comes to £4, 10s., 0d. Single numbers are 14s 4d including postage.

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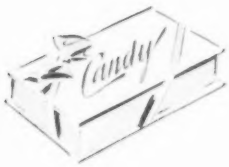
(Continued on page 34)



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BOOKS

(Continued from page 32)

The abstracts cover a wide range of journals. Citations are given in the original language and also in English. The subject classification is as follows: I, Meat (including Pig Flesh); II, Poultry and Game; III, Fish and Shellfish; IV, Eggs; V, Dairy Produce; VI, Fats and Oils; VII, Fruits and Vegetables; VIII, Cereal Grains, Pulses, Edible Nuts, Seeds, Forage Crops; IX, Sugar, Syrup, Confectionery, Tea, Coffee, Cacao Products, Spices, Flavours, Condiments; X, General Processing and Chemical Engineering; XI, Physics and Refrigerating Engineering; XII, Packaging Methods and Materials; XIII, Miscellaneous.

With Number 1 of Volume 25 (January, 1953), the issues were expanded from 100 to 124 pages. From Volume 1 (1929) to Volume 17, the title was *Index to the Literature of Food Investigations*. During the war years publication was irregular and some of the volumes are incomplete, but publication is planned.

H. C. Diehl.
Colorado Springs, Colorado

Selected Abstracts*

ANALYTICAL METHODS

Chromatographic techniques. I. The principles of chromatographic analysis.

Whitmore, J. *Lab. Practice, 2,* 301-5 (1953).

Technics, and properties of adsorbents and solvents are discussed.

The chemistry of vegetable tannins. VIII. Chromatographic studies.

Putnam, R. C., and Bowles, A. V. *J. Am. Leather Chemists' Assoc., 68,* 343-9 (1953).

The mobilities of four phlobatannins were measured by paper ionophoresis. The mobilities were found to increase with pH. The tannins do not fluoresce in ultraviolet light. Fluorescent impurities move more slowly than the tannins. A two-way electrochromatogram of quebracho tannin was prepd. and found to reveal no new spots. Solvent chromatograms of four phlobatannins were prepd. and their R_f values measured.

The tannin of apple juice and cider. An interpretation of the permanganate titration method.

Williams, A. H. *Chem. & Ind.,* 540-1 (1953).

The permanganate figure is due mainly to phenolic substances, and the evidence of pptn. expts. with gelatin and hide powder suggests the presence of a no. of different phenolics forming a group with very similar properties. The method of paper chromatography was applied to their sepn. All the phenolics so far identified in the apple contain the catechol grouping, and tests on a range of phenolics suggest that the permanganate method is specific for the *o*- and *p*-dihydroxy benzene structures. Mono-hydric phenols, or those with the *m*-dihydroxy benzene structure, do not react. The permanganate titration of apple tannins is in effect an estn. of catechol groups. Pptn. by gelatin or hide powder cannot be the basis for a rigid distinction between true "tannins" and polyphenols. Pptn. by gelatin is selective but very dependent on the amt. of gelatin added; hide powder, on the other hand, removes the major part of the simple polyphenols as well as the bulk of the complex compds.

Bromide residues: determination in fresh fruits after fumigation with ethylene dibromide.

Tanada, A. F., Matsumoto, H., and Scheuer, P. J. *J. Agr. Food Chem., 1,* 453-5 (1953).

A method is described for the detn. of ethylene dibromide and bromide residues in fresh fruits and vegetables which were fumigated with ethylene dibromide.

Determination of particle size distributions by a sedimentation method.

Smith, J. S., and Gardenier, R. *Anal. Chem., 25,* 577-81 (1953).

A simple app. for the detn. of particle size distributions as functions of the Stokes diam. in liquid media is described. A scheme is presented for computing results in such a way that it is not necessary to use Oden's tangential intercept method in routine analyses. The distributions are described in terms of their mean Stokes diam. and second moments about the mean.

Anionic detergents.

Lewandowski, T. *Soap and Sanit. Chemicals, 29,* 49-52, April, 1953.

A rapid, simple, accurate method for detg. concns. of synthetic detergents, based on color reactions produced after combining the anionic solns. with cationic detergent-brom phenol blue mixts. is described. The method is not applicable for soaps.

The reaction between periodic acid and polyhydroxy compounds.

Tompsett, S. L., and Smith, D. C. *Analyst, 78,* 209-16 (1953).

The liberation of formaldehyde when a no. of polyhydroxy and aminohydroxy compds. react with periodic acid was studied by two procedures. The formaldehyde is detd. colorimetrically with chromotropic acid. The analytical application of this reaction is discussed and applications are made to more complex substances, human urine and blood.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

A new sulfur-containing amino acid from subtilin.

Alderton, G. *J. Am. Chem. Soc., 75,* 2391-2 (1953).

The isolation and some properties of a new naturally occurring thioether amino acid from the antibiotic peptide subtilin are described. The structure is proposed as one of the α-amino-β-(2-amino-2-carboxyethylmercapto-)-butyric acids. The configurations at the two α-carbon atoms were detd.

A production of amino acids under possible primitive earth conditions.

Miller, S. L. *Science, 117,* 528-9 (1953).

In order to test the hypothesis that org. compds. which serve as a basis of life were formed when the earth had an atm. of CH_4, NH_3, H_2O and H_2, an app. was built to circulate these compds. past an elec. discharge. The resulting mixt. was tested for amino acids by paper chromatography. Glycine, α-alanine and β-alanine were identified by this method. Doubtful spots were also obtained which may correspond to aspartic acid and α-amino-n-butyric acid.

The mechanism of carbohydrase action. Part II. α-Amylolysis of linear substrates.

Whelan, W. J., and Roberts, P. J. P. *J. Chem. Soc.,* 1298-1304 (1953).

The action of salivary α-amylase on amylose yielded only maltose and maltotriose. The ratios of these were found to be in exact agreement with Meyer's theory, which states that α-amylase can hydrolyze any except the two terminal linkages. The susceptible linkages were all hydrolyzed at the same rate.

Nine chemicals to digest fat.

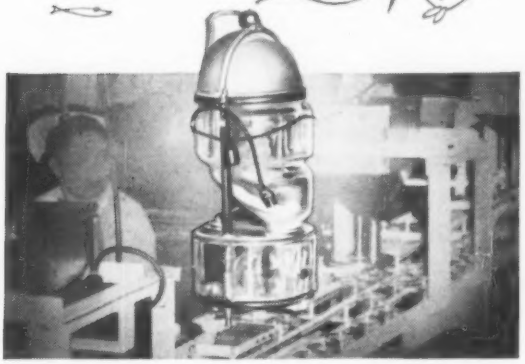
Science News Letter, 63, 200 (1953).

Nine semi-living chem. substances known as enzymes must work in unison for fat digestion. The enzymes necessary for

(Continued on page 36)

* These Selected Abstracts are made available to Food Technology through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

Ever hear this fish story—about the big one that...



ONCE UPON A TIME there was a fish packer with a problem. He could catch all the fish he needed, but customers were harder to come by. They were much, much harder to catch than fish.

Their tastes were more refined. Taste? He thought about that for a moment. If taste was the problem, why not call in the flavor experts on the Ac'cent Technical Service Staff?

He did. And because of that there's a happy ending to this story.

The device at the top of this page—an Ac'cent applicator—was developed after extensive research and laboratory tests by the Ac'cent Technical Staff. Engineers from Ac'cent's 75-man research and development staff installed the machine on the production line.

The fish packer's problem was solved. He is now a leader in his field. His customers are repeat customers. They come back again and again for the flavor they like.

Ac'cent food experts have given many processors the help they needed with new products, timing devices, applicators, and a variety of processing problems.

They are ready to help you, too, with their wealth of technical knowledge which has been built up by Ac'cent's intensive research on its sole product—pure monosodium glutamate.

Established in 1946, our research department pioneered in exploring the uses and value of this remarkable food product. New developments, of course, have been passed on to our customers, giving many of them a lasting competitive advantage.

Ac'cent laboratories have been the origin of most of the authoritative information that exists on monosodium glutamate. As a result, no other manufacturer of monosodium glutamate has such a vast and complete store of information on the subject. That is one of the reasons why leaders in the food processing industry call on Ac'cent for reliable, scientific advice.

No other manufacturer of monosodium glutamate has done as much as Ac'cent to win consumer acceptance. A few years ago Ac'cent launched the most extensive educational campaign ever attempted to overcome public resistance to monosodium glutamate. It was so successful that housewives now actually *look for it* on labels.

Ac'cent has become a household word, a topic of conversation when food is discussed, and is so much in demand that we have had to expand our already large facilities at San Jose, California.

The world's largest producer of pure monosodium glutamate is now able to serve you better than ever before with the most uniform crystal of monosodium glutamate in the industry. Assuring quick, dependable service are our warehouse stocks in every key market.

If you have a sales problem that better taste might help, think of the fish that pulled in customers...customers that came back for more.

When you order monosodium glutamate, specify Ac'cent. You get so much more when you do.

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Chicago, Illinois

WESTERN DIVISION
E. O. Freeman
214 Front Street
San Francisco, California

SOUTHEASTERN DIVISION
D. F. Hankinson
460 Melliview Avenue, S.W.
Atlanta, Georgia

EAST-CENTRAL DIVISION
S. E. Juratovic
90 Hamlin Avenue
East Aurora, New York

SOUTHWESTERN DIVISION
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...makes good food taste better!

AMINO PRODUCTS DIVISION OF INTERNATIONAL MINERALS & CHEMICAL CORPORATION, 20 NORTH WACKER DRIVE, CHICAGO 6, ILLINOIS

SELECTED ABSTRACTS

(Continued from page 34)

utilization of food chemicals are found in microscopic rod-shaped structures around the nucleus of cells in the body. From these structures the nine essential enzymes have been sepd. Six of the nine had never been isolated before. Fatty acid digestion is in some ways similar to the previously known, but less complicated, breakdown of sugar in the body.

Dividing nuclei in coconut milk.

DUTT, M. *Nature, 171,* 799-800 (1953).

Coconuts and allied fruits are good sources for obtaining measurable quantities of free nuclei, and may also be observed for chromosomes. They are easily accessible, yield a great deal of material and may be stored for days without deterioration.

Chemical helps fight A-bomb burst effects.

Science News Letter, 63, 245-6 (1953).

Protamine sulfate may protect against two major radiation hazards—tendency to bleed and increased susceptibility to infection.

Furan chemical makes male rats infertile.

Science News Letter, 63, 262 (1953).

In the presence of nitrofurans, the sperm-producing cells in rats are unable to secure the necessary energy for continued development and remain as immature cells until treatment is withdrawn.

NUTRITION

Specific dynamic action of protein in men past sixty years of age.

TUTTLE, W. W., HORVATH, S. M., PRESSON, L. F., AND DAUM, K. *J. Appl. Physiol., 5,* 631-4 (1953).

The responses of old men (mean age 77 years) and young men (mean age 24 years) to the ingestion of a standard protein test meal, which yielded 25 g. protein, were compared. The S. D. A., expressed as total excess oxygen utilization, was essentially the same in both age groups. The older subjects exhibited a slower initial response to the protein meal but had both higher peak values and increased excess O_2 utilization during the second half of a 4.5-hr. test period.

Fat emulsions for oral nutrition. IV. Metabolic studies on human subjects.

VAN ITALLIE, T. B., LOGAN, W. B., SMYTHE, R. L., GEYER, R. P., AND STARE, F. J. *Metabolism, Clin. and Exp., 1,* 80-8 (1952); *Excerpta Med., 6,* No. 350 (1953).

When large amts. of fat are added to the diet the food is not accepted in the majority of cases, probably owing to its taste or to epigastric distress produced by the inhibition of gastric peristalsis caused by the presence of fat in the upper intestinal tract. In an attempt to avoid such objections, a new high caloric prepn. (fat emulsion) for oral use, contg. 40% fat and 10% glucose providing as much as 4 cal./g. is described.

Fat in diet protects from radiation damage.

Science News Letter, 63, 245 (1953).

Salad and cooking oils, margarine, mayonnaise and lard contain essential fatty acids which kept lab. rats alive, even when they were subjected to crit. doses of x-rays similar to those given off by an atomic blast. Nothing, including the greatest amts. of mayonnaise on salads, protected against fatal doses of x-rays given to the rats.

An unrecognized nutritional factor (cornstarch) required by the duck.

MILLER, O. N. *J. Nutrition, 50,* 13-21 (1953).

Data are presented which indicate the existence of a new and as yet unidentified factor important for the nutrition of the duckling. This factor (CSF) is found is cornstarch and certain refinery products of dextrose production as well as in crude dextrose itself. A deficiency of this factor manifests itself in the duck by a greasy, unkempt appearance with poor feathering, poor growth rate, and acute pancreatic fibrosis.

Caloric intake in relation to physique in children.

PECKOS, P. S. *Science, 117,* 631-3 (1953).

"Obesity" or "leanness" is not accounted for by some common factor in all children. It is suggested that three factors must be considered: (a) genetically detd. differences in food utilization and tendency to deposition of fat, (b) different activity rates, (c) differences in heat loss relative to body mass.

PHARMACOLOGY AND TOXICOLOGY

Special toxicity of methyl alcohol as compared with ethyl alcohol.

SIMON, I. *Athena 18,* 203-8 (1952); *Excerpta Med., 6,* No. 1009 (1953).

EtOH (I) has greater immediate and delayed toxic effects than MeOH (II), but is rapidly and almost completely oxidized in the organism, whereas II is taken up and retained by the tissues (especially those of the central nervous system), which are unable to eliminate it or convert it into a less toxic substance. This is believed to be the true cause of the toxic effect of II. The hypothesis of conversion of II into formic acid (III) is rejected on the following grounds: (1) if III were formed it would be at once eliminated by the kidney; (2) III is even more toxic than II; (3) the clinical picture of the toxic action of III is different from that produced by II.

PHYSIOLOGY AND MEDICINE

The mechanism of the protective action of glycerol against haemolysis.

LOVELOCK, J. E. *Biochim. et Biophys. Acta, 11,* 28-36 (1953).

The effects of including glycerol in suspensions of human red blood cells during freezing and thawing were observed. The results of these observations confirm that damage on freezing results largely from the concn. of the electrolytes within the cell. In the presence of glycerol this concn. of electrolytes by freezing is greatly reduced, and is sufficient to explain its protective action. From this interpretation of the action of glycerol, improvements are suggested in the technic of preserving red blood cells at low temps.

Chemical controls aging.

Science News Letter, 63, 334 (1953). Normal aging of the body's cells apparently is governed by a thin surface layer of ribonucleoprotein. This veneer seems to enable cells to take up several chemicals, including Ca, from its environment.

DETERGENTS

New test aids in detergent selection.

Rohm and Haas Reptr., 11, 20-3, May-June, 1953.

A procedure developed by Rohm and Haas, shows that nonionic detergents are superior for cleaning hard surfaces. The importance of the substrate (the soiled surface) in the cleaning process is stressed.

FOOD AND FOOD TECHNOLOGY

COCOA

Annual report of the Cacao Research Institute.

Trop. Agr., 29, 131 (1952).

The first Annual Report of the Institute founded in Hamburg in 1951. Report consists of review type papers including ones on pest problems, compn. of fermented cacao, a new process for treating underfermented and diseased cacao, and the photoelec. classification of cacao beans by the anthocyanin content.

FLAVORS

Coumarin substitute.

Oil, Paint, Drug Reptr., 163, 61, June 22, 1953.

(Continued on page 38)

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Only Morton can offer the *right* salt for your canning operation—at the *right* time, at the most favorable price and freight—*anywhere* in the country. This is made possible by Morton's *nine* plants, strategically located to service the entire country. That's one good reason why it pays to standardize on Morton Canning Salt and service.

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SELECTED ABSTRACTS

(Continued from page 36)

A new product called "Dolcourin" has been developed. It contains no coumarin or coumarin derivs. and is suggested for use in any formula in which coumarin or tonka has been used.

GELATIN

Acid and alkaline hydrolysis of gelatin.

CROOME, R. J. *J. Appl. Chem., 3,* 280-6 (1953).

A study was made of the thermal decompn. of an alk. ossein-gelatin in dil. solns. of HCl and NaOH within a pH range of 3.05 to 9.85. Reaction temps. of 60°, 70° and 80° were employed, the reaction being followed by the decrease in jelly strength, measured by the Bloom Gelometer, of gels, matured at 10°, after having undergone thermal treatment in the sol. form. The reaction is first-order, and is catalyzed by both H and OH ions. Variation of the velocity coeff. with pH is represented by a catenary curve that exhibits a fairly well defined point of min. velocity at pH 6.4. The catalytic coeffs. of the H and OH ions were detd. for the reaction temps. employed. The reaction velocity coeff. varies with temp. according to the equation of Arrhenius, and values of the heat of hydrolysis were calcd. from it. These were found to be considerably higher on the acid side of the isoelec. point than on the alk. side, up to pH 9.35, beyond which they rise again. This variation with the pH of the sol is explained by visualizing the mechanism of the reaction as being different for concns. of catalyst greater than, and less than about 0.03 *N*.

The roles of the amino and hydroxyl groups of collagen in its reactions with formaldehyde, tannic acid and quinone.

GREEN, R. W. *J. Am. Chem. Soc., 75,* 2729-32 (1953).

The controlled partial acetylation of collagen at its amino and hydroxyl radicals was used to investigate the functions of these groups in some reactions with common tanning agents. The binding of formaldehyde, tannic acid and quinone is examd. as a function of the degree of acetylation, and possible interpretations of the exptl. data are discussed.

FISH

Chemical studies on the substances of fish smell. Oxidation products of piperidine.

YAMANISHI, T., AND OBATA, Y. *Bull. Japanese Soc. Sci. Fish., 18,* 102-4 (1952); *Biol. Abstr., 27,* 1451, No. 15757 (1953).

The authors oxidized piperidine with H_2O_2 and $FeSO_4$. Ether exts. gave δ-aminovaleraldehyde, a white waxy substance, and crystals of δ-aminovaleric acid, which have strong fishy odors. An aq. soln. contained a white waxy substance with a melon-like aroma and a viscous liquid with putrefactive odor.

PECTIN

Isolation of tetragalacturonic acid from enzymatically degraded pectinic acid.

ALTERMATT, H., AND DEUEL, H. *Helv. Chim. Acta., 36,* 340-2 (1953).

Pectinic acid was partially degraded by a mold polygalacturonase. Pure tetragalacturonic acid was isolated from the hydrolysate.

The hydrolysis of pectic acid by purified fungal polygalacturonase.

RAHMAN, MD. B., AND JOSLYN, M. A. *Food Research, 18,* 308-18 (1953).

The course of hydrolysis of 2 pectic acids by purified PG prepn. from 3 fungal sources was studied. The course of hydrolysis was followed by the detn. of changes in total pectic substances (Ca and alc. precipitable matter) and by increase in reducing power and mono-galacturonic content. Changes in viscosity, sp. optical rotation and osmotic pressure were also measured. During enzyme action, viscosity dropped more rapidly than did the increase in reducing value.

ORGANIC CHEMISTRY

Application of countercurrent distribution to Valencia orange juice carotenoids.

CURL, A. L. *J. Agr. Food Chem., 1,* 456-60 (1953).

The fractionation of carotenoids by means of countercurrent distribution in a glass Craig app. was studied. By the use of two different solvent systems, a total of six fractions was obtained, which were identified as: (a) hydrocarbons; (b) monohydric alcs.; (c) diols; (d) and (e) diols contg. in addn. one or two cyclic ether groups, resp.; and (f) polyols contg. more than two hydroxyl groups. Chromatography of fractions (a), (b), and (c) for Valencia orange juice constituents resulted in the identification of phytofluene, α-, β-, and ζ-carotenes, cryptoxanthin, zeaxanthin, and lutein. Another fraction was tentatively identified as hydroxy α-carotene.

PACKAGING

Measuring package odors.

Modern Packaging, 26, 149-50, June, 1953.

A standard procedure for identifying and rating odors in materials is suggested by a joint committee of Tappi and PI.

PHYSICAL RESEARCH

Some factors influencing foam stability.

SPORCK, C. R. *J. Am. Oil Chemists' Soc., 30,* 190-3 (1953).

It is believed that liquid films owe their stability to the Gibbs elasticity. How this elasticity may arise is discussed, and it is concluded that in some cases a nonequil. value may be the important concern. Some data on surface compn. from radiochem. expts. and foam fractionation are presented. Finally an explanation of the origin of the slow and fast draining films of Ross, Miles, and Shedlovsky is offered.

Further evidence concerning the periodic structure in collagen.

KAESBERG, P., AND SHURMAN, M. M. *Biochim. et Biophys. Acta, 11,* 1-6 (1953).

Patterson distributions were constructed from x-ray diffraction patterns produced by the large periodicity in beef tendon collagen. The Pattersons were interpreted in terms of the intraperiod fine structure observable in electron micrographs of collagen. It is suggested that there may be a single high density band in wet, unstained collagen and a very detailed band structure in wet, stained collagen. The Patterson from dry, stained collagen is in satisfactory agreement with one calcd. from idealized structure suggested by electron micrographs.

The surface areas of proteins. V. The mechanism of water sorption.

SEEHOF, J. M., KEHLN, B., AND BENSON, S. W. *J. Am. Chem. Soc., 75,* 2427-30 (1953).

The sorption of water by solid proteins is characterized by the evolution of heat, a peculiar hysteresis, swelling of the solid and an increase in the surface area of the solid. Heat evolution is of the order of magnitude of the heat of vaporization of water and in conjunction with the poor thermal conductivity of the protein acts to slow the sorption considerably. It is proposed that the hysteresis is assocd. with binding on the free basic groups of the protein. The existing data on sorption do indeed show an excellent correlation between no. of free basic groups and the max. amt. of hysteresis and an hypothesis is suggested for such a correlation.

Fundamental structure for protein materials.

Science News Letter, 63, 203 (1953).

One fundamental pattern repeated with variations makes up most protein materials from gelatin to blood. The pattern is that of a coiled spring, and the variations are found in whether the spring coils in the right-hand or left-hand direction and in how many fibers, themselves twisted, curl around one another to form the fibrous threads that make up the protein substance. Hemoglobin, serum albumin from blood, an enzyme from egg

white, and insulin have the same coiled form previously identified in horn, hair and skin. Gelatin and collagen are simpler proteins whose structure also seems to follow the pattern. Three twisted chains appear to make up their fibers.

RADIOCHEMICAL TECHNOLOGY

Reactor-produced radioactive isotopes.

INGRAHAM, S. C., TERRILL, J. G., AND MOELLER, D. W. *Public Health Repts., 68*, 609-15 (1953).

A review on the amt. of radioactive isotopes in use, regulations concerning shipment and use, and levels of radiation exposure received by workers.

Carbon isotope effects in biological systems.

BUCHANAN, D. L., NAKAO, A., AND EDWARDS, G. *Science, 117*, 541-5 (1953).

Tracer studies are subject to error when labeled and unlabeled mols. differ quantitatively in chem. and phys. properties. This paper reviews the biol. systems in which the isotope effect must be taken into consideration.

PATENTS

Method of preserving avocados.

HEINRICH, H. W. 2,641,548, June 9, 1953.

The method of preserving avocado meat which includes blanching the meat in an edible vegetable oil for about one minute at a temp. of from 185° F. to 220° F.

FUTURE DATES FOR FOOD TECHNOLOGISTS

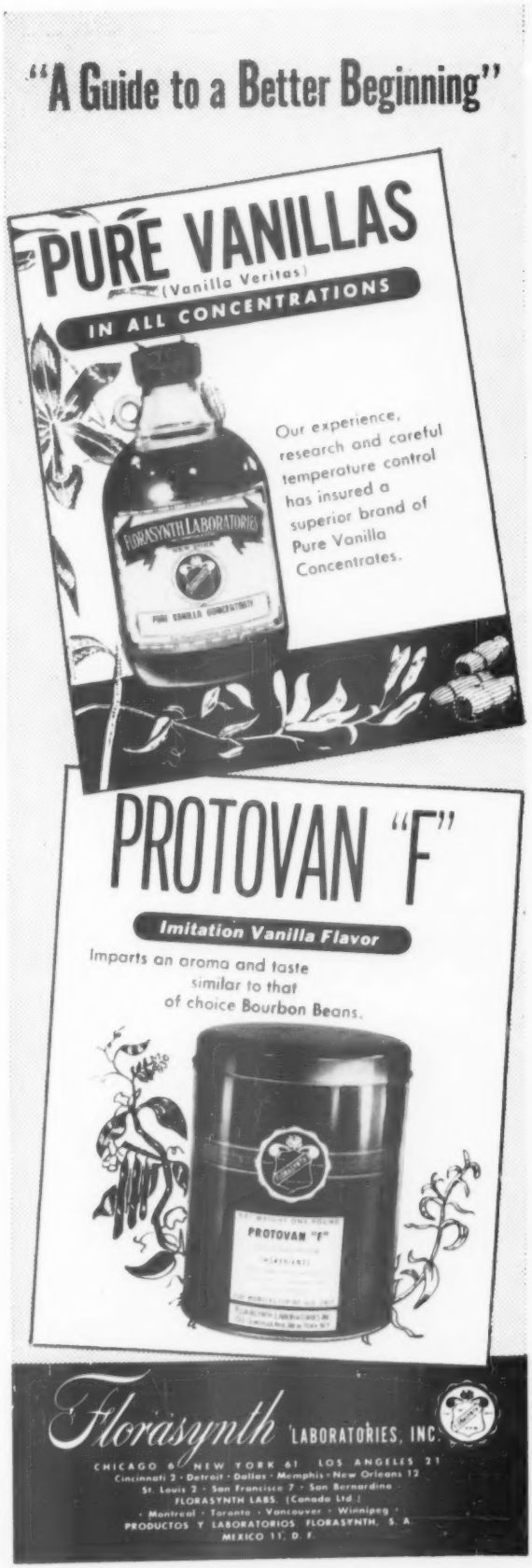
1953

November 2-4	Fall Meeting of the American Oil Chemists Society, Chicago.
November 9-12	International Soft Drink Industry Exposition, Chicago, Illinois
November 11-13	Association of Food Industries Sanitarians, Berkeley, California
November 20	Dairy Industries Society, International, Washington, D. C.
November 23	Manufacturing Chemists Association, New York, N. Y.
December 13-16	Annual Meeting of the American Institute of Chemical Engineers, St. Louis, Missouri
December 26-31	Annual Meeting of the American Association for the Advancement of Science, Boston, Massachusetts

1954

January 18-20	National Potato Chip Institute, Cincinnati, Ohio
January 22	National Poultry and Egg Board Meeting, Chicago, Illinois
January 22	Annual Meeting of the National Wooden Box Association, Chicago, Illinois
January 31-February 1	Meeting of the American Dehydrators Association, New Orleans, Louisiana
February 1954	Annual Meeting of the National Soup Mix Association, Chicago, Illinois
February 1-4	Frozen Food Industry Convention and Exhibition, New York, New York
April 22-23	National Meeting of the American Dry Milk Institute, Cleveland, Ohio
May 2-5	Annual Meeting of the National Fisheries Institute, Cleveland, Ohio
June 23-25	Seventh Annual Meeting of the Research and Development Associates, Food and Container Institute, Los Angeles, California
June 27 to July 1, 1954	**Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)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. . . in the public interest

A letter from Secretary of Agriculture Benson to IFT Executive Secretary Lawrence permits us to open the November column on a trumpet note of national interest. The following excerpts speak eloquently for themselves:

"The Federal Government is now confronted with a great accumulation of problems associated with agricultural surpluses and declining farm prices. We must have a program which considers not only the immediate impact of these problems, but also their real solution over the years ahead. Looking to the future, I am convinced of the need for a bigger and better research program with the results being carried into application more adequately through education. This is the route to lower farm production costs, a better quality of farm products, and expanding farm markets.

"An increasing awareness among all groups interested in agriculture of the real significance of research and education has been in evidence for some time. We in the Department have given a great deal of study to this subject. We have had many searching discussions with farmers, the farm and commodity organizations, people from the Land-Grant Colleges, representatives of industries serving agriculture, and others.

"My reaction to . . . their . . . proposals is certainly favorable, but in developing the recommendations of the Department, I am anxious to have the benefit of the widest possible cross-section of agricultural opinion throughout the country. It would be most helpful if all organizations interested in agriculture could give serious consideration to this subject and let us have their views. I hope it will be possible for your organization to cooperate to this end."

◆ ◆ ◆

Dedication to the American public of an important patent relating to the use of lysine—an amino acid essential to human nutrition in the fortification of bread and other cereal foods—has been announced by the Du Pont Company. This patent has been placed on the Register of Patents in the U.S. Patent Office in the form of a free license to the Government and people of the United States, whereby anyone who wishes may carry out the invention of a royalty-free basis. All rights to U.S. Patent 2,344,229 on lysine fortification of cereal foods, issued to Richard J. Block and Diana Bolling, were purchased recently by Du Pont from C. M. Armstrong, Inc., a subsidiary of American Maize Products Corp.

◆ ◆ ◆

"The packaging industry, as we know it today, could not exist without the machine tool," explains an educational bulletin received from American Can Company. Last year at the seven machine shops operated by American Can, over 15,000,000 pounds of metal and primary high grade steel, comprised of castings, forgings, and bar stock were converted into can making and can closing machines and auxiliary equipment. Eighty-five percent of the can company's 1952 capital expenditures of almost $35,000,000 was for equipment. This included equipment for the company's new plants and for added production and increased efficiency in existing facilities, as well as for closing machines and related equipment for canners, dairies, and other container users. At Canco's modern shops, some 4,500 men and women use high-precision machine tools to create intricate, efficient, and economical instruments of mass-production. The bulletin concludes by pointing out Canco's double role in this country's can-making revolution in the early 1900's through the perfection of the modern open-top metal can as well as the high speed machines to manufacture, fill, and close the open-top container with its double-seamed ends. The double seamer still remains one of the century's machine miracles, points out the company, and it is due to such machines as this and other automatic equipment that within half a century can-making speeds have increased from about 60 per minute to 450 cans per minute.

◆ ◆ ◆

American boys are returning from Korea with a greatly improved appetite for macaroni products, according to Mr. Thomas A. Cuneo, president of the National Macaroni Institute. In recalling that consumption of macaroni products by the armed forces was 14.2 pounds per capita compared to less than half of that for the civilian population, Mr. Cuneo opined that the Army Quartermaster Corps evidently selected macaroni products as an energy-building food for fighting men.

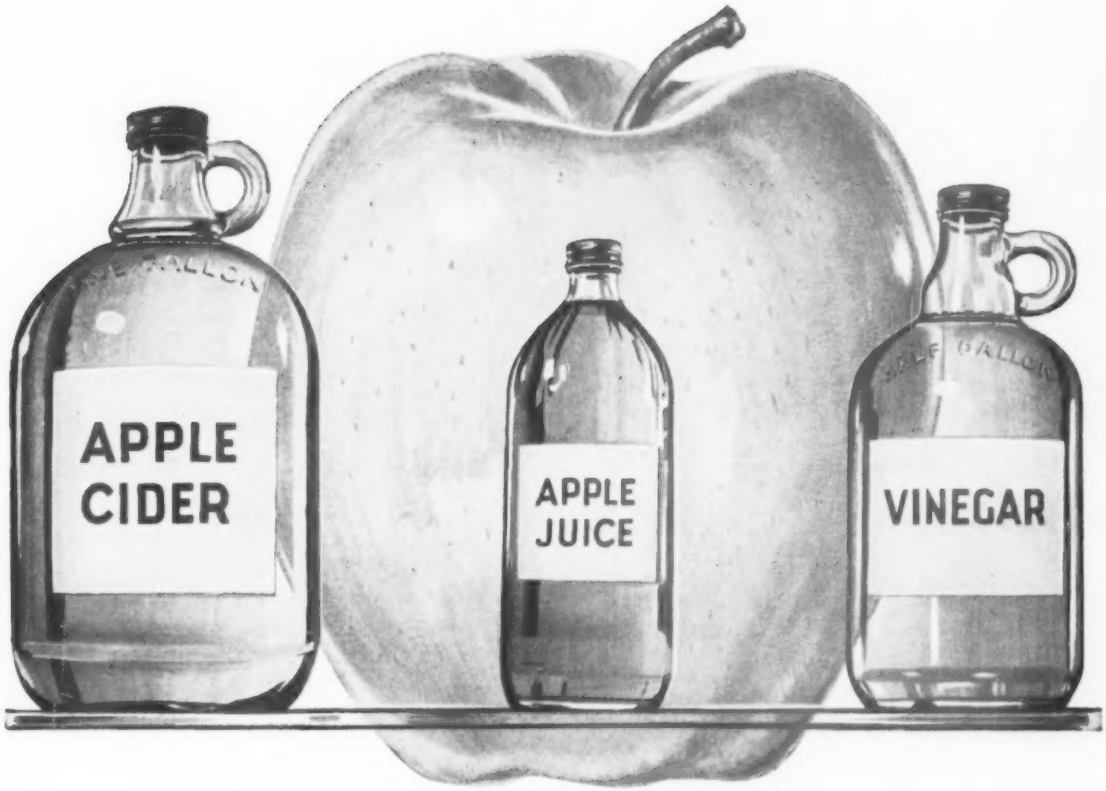
◆ ◆ ◆

Miss Bertha M. Garber, director of the New York Institute of Dietetics, 66 Fifth Ave., New York City, has announced a full scholarship to the Institute given by Mrs. Tillie Lewis, president of Tasti-Foods, Inc., and Flotill, Inc., Stockton, Cal. The scholarship award will be made on the basis of an essay on the subject of "Why I Want to be a Dietician" and will be for the sum of $750. The winning student may attend either day or evening classes, thus making it possible to take a part-time job, if necessary, as an aid toward living expenses in New York. The contest opens October 1 and closes December 31 of this year. Essays must be not less than 500 nor more than 1,000 words in length. Contestants must submit with the essays brief biographies, including full name, age, educational background, organizations with which affiliated and work experience. All entries for the scholarship award should be sent to the Tillie Lewis Scholarship, N. Y. Institute of Dietetics, 66 Fifth Ave., New York 11, N. Y.

◆ ◆ ◆

In connection with the 50th anniversary of the California canned tuna industry, the Tuna Research Foundation has announced the greatest sales, advertising, and publicity program ever placed behind canned tuna from California. The campaign will reach its peak during National Tuna Week, November 5 to 14. According to Mr. E. L. Morris, Foundation director, homemakers are searching for lower-priced, high protein foods, and tuna offers an excellent source. Stressing the importance of tuna in the nation's economy, he pointed out that a recent U. S. Fish and Wildlife Service report showed that tuna worth $113,000,000 headed the list of canned fishery items in 1952. Salmon was next

(Continued on page 42)



How CELITE filtration gives apple products more eye-appeal, longer shelf-life

Celite* Filter Aids enable apple processors to secure brilliantly clear filtrates in their finished products. Celite provides such efficient filtration that it removes most material which promotes fermentation.

The result is a product with longer shelf-life, more eye-appeal—more "buy" appeal. Not only do Celite Filter Aids improve product quality, but they also permit high flow rates with long filtration cycles.

For maximum juice yield from your presses, a small amount of Celite should be used as a pressing aid. Celite Pressing Aids help produce a firm dry cake which can be easily and completely stripped from the cloth.

You are assured of highest product quality with Celite, for it is carefully processed from the purest deposits of diatomaceous earth. Celite is an extremely light weight, highly porous powder. It is chemically inert, insoluble, and specially treated so that it imparts no foreign flavor to fruits or foods.

To speed production and improve product quality, Celite is used in the processing of many foods and beverages such as sugar, fruits and juices, beer and wine. A Celite field engineer will gladly show you how Celite Filter and Pressing Aids can help your product or process. For his services simply write Johns-Manville, Box 60, New York 16, N.Y. In Canada, 199 Bay St., Toronto 1, Ontario.

*Reg. U. S. Pat. Off.

JOHNS-MANVILLE PRODUCTS

Johns-Manville CELITE FILTER AND PRESSING AIDS

FOOD INDUSTRY TOPICS

(Continued from page 40)

with $98,000,000 and sardines third with $22,000,000 worth of canned product.

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A five-year nutrition research program undertaken by the National Association of Frozen Food Packers will employ a statistical sampling plan designed to provide an impartial cross section of grades, varieties, regions, climatic conditions, and methods of processing, packaging, and freezing. During 1953, personnel in 149 freezing plants expect to save about 15,000 samples which will be tested for eight vitamins, six minerals, and seven proximate components. Sampling and testing will be repeated next year. Full details on this comprehensive sampling of 48 frozen fruits, juices, and vegetables are available from the Association, 1415 K St., N. W., Washington 5, D. C., by requesting "Sampling Plan."

. . . *things new under the sun*

A new, natural vegetable colloid known as JAGUAR is being offered to the food industry by Stein, Hall and Company, Inc., New York City. The new product which is refined guar gum is being produced for the first time in commercial quantities according to Mr. Lawrence Gussman, vice president in charge of research and production. The company, established in 1866 and a leading processor of water soluble gums for over 25 years, is confident JAGUAR will be of widespread interest in the food processing field because it produces high viscosity at low concentrations, swells quickly in cold water and develops its properties over a wide pH range. A natural, vegetable, pure food colloid, it has excellent thickening, film forming, and stabilizing properties. Among food industry uses listed by Stein, Hall are the stabilization of cheese spreads, salad dressings, cold dessert preparations, frozen fruits and fruit drinks, cake icings, and prepared meats. (Based on detailed testimony, the FDA has included guar gum in the standards of identity for both cheese and salad dressing.) Important uses for the new product are also being developed in the pharmaceutical, cosmetic, and other industries.

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A new machine for filling viscous and liquid products has just been introduced by the Hope Machine Co., 9400 State Rd., Philadelphia 14, Pa. Called the Type 19A, the machine is the culmination of 30 years experience, and can be used for filling glass jars, plastic bottles, tin cans, and paper cups. Hope has tested the Type 19A in filling containers of mayonnaise, salad dressing, french dressing, jellies, jams, preserves, sauces, liquid soaps, glue, grease, cosmetics, pharmaceuticals, and various other viscous products. Production speeds up to 250 containers per minute have been achieved on some items. The machine offers accurate quantity adjustment from ½ fluid ounce to 32 ounces. However, on some cosmetic operations, accuracy has been held to 1/10 gram. A full line of accessories is available.

Machine for filling viscous and liquid products. Production runs up to 250 containers per minute have been achieved.

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Chase Bag Co., 309 W. Jackson Blvd., Chicago 6, Ill., manufacturers of bags for over a century, have announced several new designs to their stock brand line of poultry bags. Made of polytex—a polyethylene plastic—Chase poultry bags remain flexible at temperatures down to 93° below zero, thus preventing the freezer burn that occurs when poultry comes into direct contact with freezer surfaces. Various styles of bags for chicken and turkey are available with and without imprint.

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The food processing industry is watching with a great deal of interest the recent development of a fire retardant paint that actually stops fire from spreading. Called Fyr-Kote, this paint is claimed to contain a mass of minute "built in" fire extinguishers; when exposed to flame, Fyr-Kote pours out carbon dioxide and calcium chloride which smothers the fire and retards the spread of flame right on the surface. Fyr-Kote oil base fire retardant interior flat wall paint has been listed by Underwriters Laboratories and is identified with the Underwriters' label on every can. It also passes applicable Federal specifications and the US Engineers' tests. The product is an extremely washable flat wall paint, withstanding more than 25 cycles of scrubbing with strong washing powder and boiling water. Full information, data, tests, etc., including Underwriters Laboratories classification may be obtained by writing Fyr-Kote Co., Division of Morris Paint & Varnish Co., 27th and Douglas, Omaha, Neb.

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A new method of strapping, known as the Inland Seal-less Strapping, is being marketed by Inland Wire Products Co., 3947 S. Lowe Ave., Chicago 9, Ill. It is claimed to offer a new simplicity of application, economy, and holding power. The secret reportedly lies in the machine used. In two simple operations, this machine tensions the strapping, cuts it to exact length void of waste, and effects a mechanical interlocking of the two overlapping ends of strapping that has consistently tested between 77 per cent and 86 per cent of the strength of the strapping itself. The economy of the new method results from elimination of seals, and time and cost of applying seals. The strength and resilience of the strapping, locked under tension, helps the container absorb shocks due to dropping or exceptionally rough treatment. It is said that Seal-less Strapping has in many cases permitted use of lighter and less costly packing materials, thus providing an added saving over conventional methods. Complete information of the new strapping method may be had by writing to Mr. E. A. Johnson, Jr., at the above address.

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A new fiberglass reinforced plastic tray which stacks and locks has been developed by the Molded Fiberglass Tray Co., Linesville, Pa., producers of Toteline products. Stacking lugs on four sides permits a stack of trays to be held at a 45° angle without danger of toppling. The trays eliminate the necessity for racks as the sides are open, permitting passage of air through them. This rigid, non-corrosive tray is dimensionally stable from minus 60° F. to 300° F., and is unaffected by most chemicals and alkalis. The design is ideally suited for freezing, dehydrating, and other food, chemical, and pharmaceutical material handling operations.

Plastic tubing joined to Swagelok Tube Fittings by means of a new Swagelok Insert is proving highly successful for many applications, according to Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio, manufacturer of both the insert and Swagelok Fittings. Resistance to chemical action and oxidation, non-contaminability, visibility, and extreme flexibility of Tygon plastic tubing when used in conjunction with leak-proof Swagelok Fittings and Inserts reportedly make the combination particularly desirable for laboratory use. Among numerous other applications are handling liquid food products, and piping water, gasoline, and certain oils and solutions. The company's inserts, now available in any metal, protect the tube fittings against cold flow in the plastic and support the inside dimension of the plastic tubing while the torque-free Swagelok Tubing grips and seals the outside dimension.

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A revolutionary idea in food products has gained overnight acceptance as a fast-moving item in the Middle West, and is now being handled by all major chains as well as by leading independents, reports Trenton Foods, Inc., Kansas City, Mo., in commenting on its Dinner Time Beef Pot Pie. The product, a complete meat pie with crust, is contained in a pie-pan-shaped can and requires no refrigeration. After the top of the can is removed with a can opener, the pie is baked in a 450 degree oven and serves three persons. The company believes it has scored two important firsts in the canned food industry in providing a pie complete with crust in a can that does not require refrigeration, and in packing its product in a utensil that can be used over and over in the kitchen.

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DuPont announces that one of its fungicides, a derivative of dithiocarbamic acid known as "Zerlate," has proved valuable in combating "bullseye rot," a disease of apples peculiar to Pacific Coast areas of the U. S. and Canada. Active ingredient in the fungicide is a DuPont organic chemical known as "ziram." In tests conducted by USDA plant pathologist, Dr. J. R. Lienholz, Newtown apple trees in an experimental orchard at Hood River, Ore., were sprayed on July 25 and September 18, 1952, with several fungicides. Trees receiving sprays of "Zerlate" fungicide at the concentration of 1½ pounds per 100 gallons showed only 1.8 percent canker fruit rot infection the following April, as compared to 7.9 percent canker fruit rot on unsprayed trees in the same orchard.

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Grains, dry chemicals, and other granular bulk materials can be moved horizontally, vertically, or along inclined planes by means of a new dust-tight conveyor known as the "Flowmaster." The unit comprises an enclosed endless chain fitted with specially designed flights which move material along in a continuous stream. It is particularly adaptable to medium and low-capacity operations; operations where economy is a factor; and operations in which there must be no voids in the flow of material to processing or packaging equipment. The Flowmaster is readily designed into tight places and around existing equipment. It is both self-loading and self-discharging. For additional information write to Gifford-Wood Company, Hudson, N. Y.

. . . the literary corner

What does a technical research organization have to offer? How do they tell the public about it? Foster D. Snell, Inc., New York firm of chemists and engineers attempts to solve the problem of selling consulting services in a new 22-page booklet available to anyone on request. The booklet entitled *Services* is a sort of Who, What, Where, and Why on the applied research, development, and testing that Snell offers. In fact, the booklet states on the back cover that if Snell doesn't furnish the service, they'll be glad to direct the inquiry to one of the member laboratories of the two leading consulting chemical and commercial laboratory associations. The spiral-bound booklet, profusely illustrated with work in progress and detailed shots of test equipment, starts on the tenth floor of the N. Y. laboratories and descends

(Continued on page 45)

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*Trademark

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- **JAGUAR** *produces high viscosity at low concentrations*
- **JAGUAR** *is cold water swelling*
- **JAGUAR** *develops its properties over a wide pH range*
- **JAGUAR** *has excellent thickening, film forming and stabilizing properties*
- **JAGUAR** *is a natural vegetable pure food colloid*
- **JAGUAR** *is economical to use*
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We invite your inquiry regarding this amazing, new product, developed and produced by Stein Hall. For technical data, and sample, write us on company letterhead or fill in this coupon.

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Write to nearest regional secretary, if within an area covered by a regional section, or to the Executive Secretary of the Institute, for an application form and information regarding qualifications and classifications.

FOOD INDUSTRY TOPICS

(Continued from page 43)

to the first, with a floor-by-floor description—just as though you were being given a guided tour. Copies are available by writing: Public Relations Dept., Foster D. Snell, Inc., 29 W. 15th St., New York 11, N. Y.

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Detailed information describing the laboratory services offered to those interested in Eastman's line of industrial chemicals, food-grade antioxidants, gasoline additives, and textile dyes is contained in a new 20-page, two-color brochure. Liberally illustrated with photos of a number of the individual laboratories and equipment, the booklet describes the various tests which can be conducted and products which can be analyzed. The brochure is organized into seven sections devoted to the specific services available in the food, textile, protective coating, miscellaneous chemical, gasoline, physical testing, and polymer laboratories. Copies of the brochure, entitled "Eastman Service," are available upon request to Eastman Chemical Products, Inc., Kingsport, Tenn.

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Announcement of the publication of the *Cumulative 25-Year Index* is made in the September issue of the *Journal of the American Oil Chemists' Society*. It covers the period 1917-52 and the following journals: Chemists' Section, *Cotton Oil Press*, 1917-24; *Journal of the Oil and Fat Industries*, 1924-32; *Oil & Soap*, 1932-47; and *Journal of the American Oil Chemists' Society*, 1947-52. Price is $5, and orders may be sent to the American Oil Chemists' Society, 35 E. Wacker Drive, Chicago 1, Ill. The *Index* contains these four sections: technical subjects, committees, news, and authors.

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"Flavors for Modern Industry" will be featured for the next few months in the *D & O News*, monthly publication of Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y. The first article, appearing in the September issue, presents a brief history of the dentifrice industry from the earliest known records up to the present. Among the interesting facts disclosed are that such flavors as peppermint, spearmint, wintergreen, and anise continue to be the most popular flavors, but that fruit flavors are making steady gains in the field of children's dentifrices. Readers interested in marketing a new or improved powder or cream are invited to forward a pound of their unflavored product to the D & O Flavor Department. It will be returned in finished, tubed, or packaged form, ready for individual evaluation. The publication also contains word of five new D & O odors for aerosol shave creams and a special perfume compound for use in aerosol artificial snow. Samples and specific directions for use of all of these products will be forwarded upon request . . . or trial tests conducted upon a manufacturer's product in the D & O Product Development Laboratories.

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What's New in Food and Drug Research, a highly readable and informative little mailer published by Food Research Laboratories, Inc., 48-14 33rd. St., Long Island City 1, N. Y., highlights in its September issue articles on the determination of "Chlorophyll" composition, the increase of popularity of low sodium foods, and recent legislative action on chemical additives to foods. Food Research Laboratories, Inc., established in 1922 and a member of the American Council of Commercial Laboratories, offers to food and drug manufacturers the

sol'vent

A substance capable of, or used in, dissolving something

Example: GLYCERINE!

Solvents for flavors, extracts, oils, and essences that are used in foods or diet supplements must be safe for human consumption. U.S.P. Glycerine is an excellent solvent. Its non-volatility and stability protect shelf life. It is compatible with a wide range of other ingredients. And U.S.P. Glycerine meets the all-important requirement of freedom from toxicity.

Customers *know* Glycerine, accept it, and respect your decision not to compromise with quality by using substitutes.

New Tonic for Anemia

For example, a new tonic for anemia has been developed which contains liver concentrate, rice bran concentrate, iron and ammonium citrate, peptonized iron, thyamine hydrochloride, riboflavin, niacin, and vitamin B_{12}, compounded in a highly stable Glycerine base. After testing various types of vehicles, the manufacturer reports that Glycerine provides the best stability, and also gives a better tasting product.

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vehicle	**demulcent**
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Booklets on the application of Glycerine in the food and pharmaceutical fields are available. For your copy, write Glycerine Producers' Association, 295 Madison Avenue, New York 17, N. Y.

Nothing takes the place of Glycerine

FOOD INDUSTRY TOPICS

services of its completely equipped and staffed Animal Laboratories, Bacteriological Laboratories, and Chemical Laboratories. The firm is also in a position to provide such special services as taste and odor studies, statistical design and interpretation of experiments, consultation on technical aspects of advertising and labeling, advice on technicolegal problems, and preparation and presentation of testimony for legal or administrative purposes. Dr. Philip B. Hawk is president and Dr. Bernard L. Oser director of the Laboratories.

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Although it hardly qualified as "literature," a recent mailing from Aseptic-Thermo Indicator Company, 5000 W. Jefferson Blvd., Los Angeles 16, Cal., seemed original enough to warrant recording for an amazed posterity in this column. After a proper build-up through the mail, an unidentified package was duly delivered which emitted interesting, rattling noises when jostled about. Such packages are always fascinating—particularly when they bear a California postmark—and thoughts of a long-lost Western relative sending through a packet of gold dust or some similar goodie admittedly made their presence felt in this columnist's noggin. Nor was this illusion dissipated when the wrappings were removed and a tin can was revealed. (After all, long-lost relatives sometimes do have idiosyncrasies.) After hastily locating a can-opener and undoing the lid, the prize was revealed—a packet sure enough but containing ten COOK-CHEX, a holder for same, an information booklet, and a self-addressed card. Far and away the nicest package I received all that day. (Can anyone use some extra COOK-CHEX?) At any rate, Mr. Willard M. Huyck, company president, says that this mailing has brought in a larger numerical response than any other mailing ever made for COOK-CHEX indicators.

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Armour Research Foundation of Illinois Institute of Technology has announced a new brochure describing the facilities and services available to industry for research in all phases of the food technology field. Two years of intensive planning and preparation by the Foundation's biochemistry section preceded the expansion of its Food Technology Services. The booklet explains some of the background which led to formation of expanded food technology service and outlines the potential of research in the field. IIT address is 35 W. 33rd St., Chicago 16, Ill.

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The *Fatty Acid News Digest*, published by the Fatty Acid Division of the Assn. of American Soap & Glycerine Producers, Inc., 295 Madison Ave., New York 17, N. Y., calls attention in its August issue to news items on a new commercial process for producing synthetic hydroxylated fat, a new method for synthesizing 10-hydroxy stearic acid, the acids and alcohols in perfume compounding, the safety of polyoxyethylene stearates for use as food additives, and a survey of the entire field of detergents, emulsifiers, and emulsion products as market outlets for fats and oils.

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A new 12-page booklet, "X-ray Methods of Possible Use in Clinical Laboratories," is available gratis from the Research & Control Instruments Division, North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. Prepared by Dr. Wm. Parrish, Philips Laboratories, Inc., the new publication discusses

crystallography and X-ray diffraction, identification of compounds, X-ray spectroscopy and microradiography. Illustrated with photos and drawings, the booklet cites cases where X-ray analysis methods have been employed for studying barbiturates, urinary calculi, histochemical and cytochemical problems, and diaphysis of the femur.

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"The 'ninth chapter' on how yeast is pushing back horizons by providing a powerful experimental tool in the study of the mechanism of life," is how Anheuser-Busch, Inc., St. Louis 18, Mo., describes its latest informative booklet on yeast. The current publication is entitled "Yeast and the Story of Enzymes," and answers such questions as "What are enzymes?" and "How do enzymes work?" In addition, enzymes, coenzymes, and vitamins are discussed as well as the biochemical roles of some of the yeast B vitamins.

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A wealth of printed material has been received from the UN Food and Agriculture Organization including: *F.A.O. Fisheries Bulletin*, Vol. 6 No. 3, May-June 1953, featuring information on Danish Seining; No. 9 of the FAO Nutritional Studies series entitled, "Maize and Maize Diets—a Nutritional Survey," April, 1953; No. 5 in a series of Commodity Reports on Fibers entitled, "Silk," March, 1953; and No. 4 in a series of Commodity Policy Studies entitled "Observations on the Proposed International Sugar Agree[illegible]une, 1953.

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Brookfield Engineering Laboratories, manufacturers of the Brookfield Synchro-Lectric Viscometer, as part of their service to industry, have reprinted a variety of articles and other papers bearing upon viscosity and related subjects. These "Technical Papers" have been described and classified in an "Article Reprint Request Sheet" so that interested individuals may note quickly and easily which papers may be of assistance to them and request those desired by "item number." Readers who desire a copy of this new "Article Reprint Request Sheet," may secure one by writing Mr. Richard Minard, Technical Service Dept., Brookfield Engineering Laboratories, Inc., Stoughton, Mass.

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A new hand fixture for embossing can lids has been introduced by M. E. Cunningham Co. Designated the SF-100-AE Embossing Fixture, this unit was developed for embossing size and content coding on paint can lids, and for similar can lid applications. Incorporated in the unit are the following: a stamping fixture frame; a stamping fixture with movable type; a plastic matrix; and a special gauge which centers the marking, thereby making the unit adaptable for embossing all sizes of can lids up to one gallon. Unique feature of the new unit is the fact that only male type or characters are needed. A special plastic matrix is provided to serve as the female die. This matrix can be used over and over, and it does not have to be changed as the stamping characters are changed. Data sheets on the new Cunningham SF-100-AE Embossing Fixture or a proposal on special requirements can be obtained by writing M. E. Cunningham Co., 1025 Chateau St., Pittsburgh 33, Pa.

. . . meeting hall and conference room

New nontherapeutic uses for antibiotics, advances in the technology of food packaging and recent developments in the chemistry of fats and oils were among topics discussed at six symposia held by the American Chemical Society's Division of Agricultural and Food Chemistry at the Society's 124th national meeting in Chicago, September 6 to 11. More than 60 chemists and chemical engineers representing industry, government, and education took part in the symposia, according to Dr. Arthur X. Prater of Los Angeles, Cal., chairman of the division. In addition to antibiotics, food packaging, and fats and oils, symposia were also held on problems of deterioration in food fats, rodenticides, and fermentation process control. Among the numerous important and interesting papers presented was that of Dr. Louis L. Rusoff of Louisiana State University and Dr. Lor-

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retard **RANCIDITY!**

...on High-Fat Low-Moisture Foods!

● As you know, potato chips, prepared mixes, nuts, baked goods, powdered soups and many other products that are high in fat and low in moisture are often spoiled by rancidity and the development of oxidative "off" flavors. And these factors reduce the shelf life and profit margin of many food products.

These problems may be avoided by the proper use of a new food grade salt with antioxidant, developed as a result of years of laboratory research—Diamond Crystal Salt with ANTIOXIDANT!

New Diamond Crystal Salt with *Antioxidant* is as simple to use as common table salt. If sodium chloride is used in your processing, this new salt will fit into your operation without extra equipment or labor.

Diamond Crystal Salt with *Antioxidant* is economical, too! The extra cost involved in salting potato chips is only about 7¢ per 100 lbs. of chips! This is a small cost to minimize returned goods.

The effectiveness, ease of use and economy of this new salt will more than justify its test in your operation. Samples are available upon request. Send for yours today!

Write to Technical Director, Diamond Crystal Salt Co., St. Clair, Michigan.

DIAMOND CRYSTAL SALT with Antioxidant

FOOD INDUSTRY TOPICS

raine S. Gall of the National Dairy Research Laboratories, Oakdale, N. Y., reporting evidence that antibiotics in feed accelerate animal growth by stimulating faster bone development. Dr. H. L. A. Tarr reported work conducted by himself, J. Boyd, and H. M. Bissett at the Pacific Fisheries Experimental Station, Vancouver, B. C., in the use of "antibiotic ice" for preserving fish.

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A highly interesting and varied program is shaping up for the 35th Annual Convention of the American Bottlers of Carbonated Beverages, to be held in Chicago's International Amphitheatre November 9-12, in conjunction with the 1953 International Soft Drink Industry Exposition. Addresses, panels, movies, demonstrations, and floor discussions are being scheduled for both the general and special sessions. In making its plans, the A. B. C. B. Convention Exposition Committee has anticipated the growing interest in new problems of merchandising, packaging, and distribution. Three of the five speakers to appear at the morning general sessions include a bottler, a franchise company representative, and an executive from outside the soft drink industry. A Panel Discussion on Industry Problems on November 11 promises to be both instructive and unpredictable. Controversial subjects in the soft drink field—returnable and non-returnable containers, non-nutritive dietetic beverages, prices, deposits—will undoubtedly come under discussion. There will be a full schedule of afternoon meetings dealing with specific problems of production, plant maintenance, sales, profit planning, public relations, and other vital topics. As always, a big feature of the convention-expositoin will be the entertainment. Further details can be obtained from A. B. C. B. Public Relations Department, Washington, D. C.

CONTINENTAL CAN COMPANY'S DISPLAY BOOTH AT THE RECENT AMERICAN DIETETIC ASSOCIATION MEETING IN LOS ANGELES FEATURED "NEW CANNED FOODS WITH A BIG FUTURE." INCLUDED IN THE DISPLAY OF ATOMIC AGE CANNING INNOVATIONS WERE CONTINENTAL'S CONTAINERS FOR DIETETIC FOODS, FROZEN CONCENTRATES, CANNED MILK PRODUCTS AND CANNED FROZEN FOODS. THE RESEARCH BULLETINS DISPLAYED ON THE CIRCULAR TABLE ARE SUMMARIES OF RECENT CONTINENTAL LABORATORY PROJECTS AND WERE AVAILABLE TO BOOTH VISITORS.

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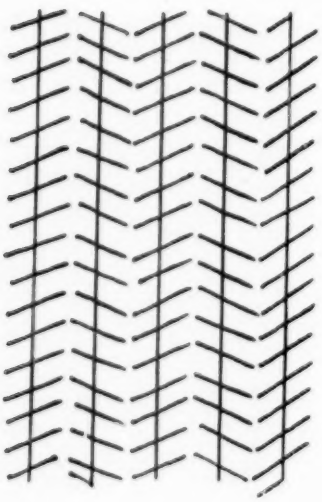
A conference of research workers and members of the citrus industry was held at the Citrus Building in Winter Haven, Fla., Oct. 8, to discuss advances in citrus processing research. The conference was held primarily to present the citrus research accomplishments of four laboratories of the Bureau of Agricultural and Industrial Chemistry, USDA: Citrus Products Station, Winter Haven, Fla.; Fruit and Vegetable Products Laboratory, Weslaco, Tex.; Fruit and Vegetable Chemistry Laboratory, Pasadena, Cal.; and Western Regional Research Labora-



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tory, Albany, Cal. Members of the citrus industry and other guests met with Bureau scientists investigating citrus utilization problems, and became acquainted at first hand with the nature, scope, and accomplishments of the Bureau's present research program on citrus utilization.

◆ ◆ ◆

Philadelphia's Convention Center will be the site of the 10th biennial American Society of Tool Engineers' Industrial Exposition, April 26 through 30, 1954, Harry E. Conrad, executive secretary of the 27,000 member and 110 chapter national technical society, has announced. Complete integration of the daytime technical sessions of the 22nd annual national meeting of the ASTE with the Exposition will be possible because all the sessions will be held inside Convention Center, he added. Floor plans and regulations for the Exposition are being made available now from the Society's headquarters at 10700 Puritan Ave., Detroit 21, Mich.

. . . *building up and branching out*

In a report to stockholders announcing new highs in sales and net profits for the first half of 1953, Mr. John E. McKeen, president of Chas. Pfizer & Co., Inc., noted the firm's entry into the hormone market through agreement with Syntex, S. A., manufacturers of steroids, and the impending acquisition of J. B. Roerig Co., Chicago, a leading supplier of hematinics and other prescription nutritional specialties. Because of the increase in its line of prescription products, the Pfizer Antibiotic Division, under the general managership of Mr. Thos. J. Winn, has been renamed Pfizer Laboratories, Division of Chas. Pfizer & Co. To this division's line of antibiotics, including terramycin, penicillin, streptomycin, polymyxcin, and bacitracin, will be added a full line of hormones including estrogens, androgens, progesterone, and the new synthetic steroid, Neodrol. Recent clinical reports have shown that Neodrol is effective in alleviating symptoms of inoperable breast cancer. Combinations of the male and female hormones will also be marketed.

◆ ◆ ◆

The Edwal Laboratories, Incorporated, became the Ringwood Chemical Corporation on September 1. The new corporate title is felt to more accurately describe the present activities of the company, which has grown in 21 years from a two-man laboratory to a major manufacturer of organic chemicals and photographic processing formulations.

. . . *the human element*

Mr. Homer C. Fritsch, executive vice president of Parke, Davis & Company, was elected director of Takamine Laboratory, Inc., at a special meeting of the Board of Directors held at Clifton, N. J., Sept. 11, 1953. Katherine McMahon Takamine, executive vice president of the firm, was elected president to succeed the late Eben T. Takamine. Hilda I. Thomas was elected secretary. Takamine Laboratory, Inc., with general offices and plant in Clifton, N. J., is one of the world's oldest and leading manufacturers of enzymes for pharmaceutical and industrial use.

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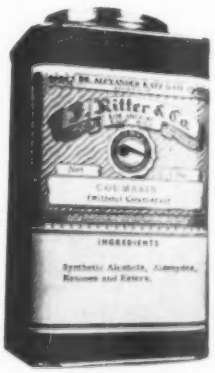
Mr. Dave Mott has been appointed Michigan sales representative for the Wm. J. Stange Co., Mr. C. A. "Tubby" Wood, Stange sales manager, announced re-



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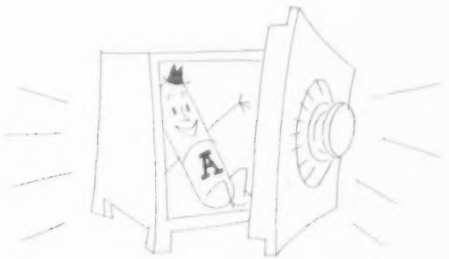

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FOOD INDUSTRY TOPICS

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◆ ◆ ◆

The retention of two eminent food technologists and a restaurant consultant as technical advisers to The Coffee Brewing Institute, Inc., 120 Wall St., New York 5, N. Y., was announced by Mr. Eugene Laughery, general manager. Dr. Samuel C. Prescott, Prof. L. H. Backer, and Mr. Arthur W. Dana will assist Mr. Laughery in planning and carrying out various phases of the Institute's research program.

◆ ◆ ◆

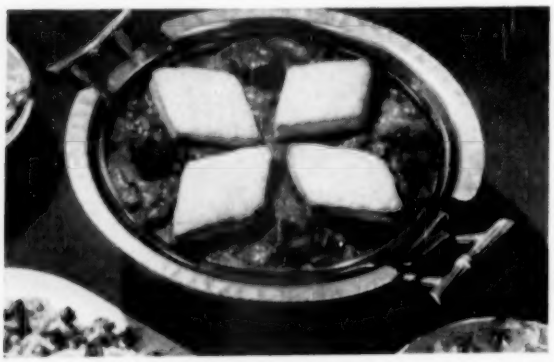
Dr. Edward L. Kropa has joined the staff of Battelle Institute in Columbus, O., as chief chemical consultant, Dr. Clyde Williams, president, revealed. He comes to the research center from The Borden Company, New York City, where he was vice president and technical director of the company's chemical division. In his new position, Dr. Kropa will serve as an adviser to Battelle's varied chemical research groups. While at The Borden Company, he served concurrently as a consultant to the National Research Council's Advisory Committee on Quartermaster problems. He was employed as chemist to the head of the resins and plastics section of the American Cyanamid Company's Research Division in Stamford, Conn., prior to joining Borden. His studies at American Cyanamid in the fields of resins, synthetic rubber, synthetic fibers, and plastics were the basis for about 100 United States patents.

◆ ◆ ◆

Dr. H. A. Trebler, director of engineering research and development of National Dairy Research Laboratories, Inc., Oakdale, Long Island, N. Y., has been granted early retirement as of August 1, 1953, as he wishes to return to his home at 14 E. Chase St., Baltimore 2, Md., in order to be closer to his various interests in that city. Dr. Trebler, who has a large number of

Advertisers' Index

	Page
Aseptic Thermo Indicator Co.	48
Brewers Yeast Council, Inc.	51
Continental Can Co.	6-7
Diamond Crystal Salt Co.	47
Distillation Products Industries	1
Dodge & Olcott, Inc.	13
Eastman Chemical Products, Inc.	49
Felton Chemical Co.	31
Firmenich, Inc.	23
Florasynth Laboratories, Inc.	39
Food Development Laboratory	52
Food Machinery & Chemical Corp.	25
Food Research Laboratories, Inc.	52
Fritzsche Bros., Inc.	52
Glycerine Producers' Assn.	45
Griffith Laboratories, Inc.	29
Hoffman-LaRoche, Inc.	9-10
Huron Milling Co.	50
Johns-Manville	41
International Minerals & Chemical Corp.	35
Klenzade Products, Inc.	51
LaWall & Harrisson	52
Magnus, Mabee & Reynard, Inc.	2
Merck & Co., Inc.	28
Morton Salt Co.	37
Norda Essential Oil & Chemical Co.	4th Cover
Pfaudler Co.	2nd Cover
Polak's Frutal Works	46
F. Ritter & Co.	49
Rohm & Haas Co.	17
Schwarz Laboratories, Inc.	52
Foster D. Snell, Inc.	52
A. E. Staley Mfg. Co.	27
Wm. J. Stange Co.	19-20
Stein, Hall & Co., Inc.	43
Sterwin Chemicals, Inc.	33
Takamine Laboratory, Inc.	15
John I. Thompson & Co.	52
Thurston Laboratories	51
van Ameringen-Haebler, Inc.	3rd Cover
Wisconsin Alumni Research Foundation	50



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papers and patents to his credit, is planning to devote a portion of his time to consulting work in the field of dairy engineering.

◆ ◆ ◆

Mr. Joseph P. Blanks, former Public Health Service Sanitary Engineer, has recently joined the consultative staff of the Orkin Institute of Industrial Sanitation, Atlanta, Ga., according to announcement made by Mr. Keith A. Fitch, executive director. Mr. Blanks has been a commissioned officer in the U. S. Public Health Service. Until accepting this new position, he was officer-in-charge of the Rocky Mountain Training Center at Denver, Colo. His special qualifications in Public Health training will be utilized by the Orkin Institute in its program designed to train industry personnel in appreciation and practice of good sanitation throughout industrial operations, and in application of efficiency to the sanitation program. His experience in sanitary engineering will also be utilized in the appraisal of equipment and plant design and of problems in the field of waste disposal and utilization.

◆ ◆ ◆

Mr. Robert M. Davenport has been named technical director and associate sales manager in charge of industrial sales of Diamond Crystal Salt Co., St. Clair, Mich., it was announced by Mr. Chas. F. Moore, president. A 1943 graduate of the University of Chicago, Mr. Davenport, an IFT member, has completed post graduate courses at several colleges in the fields of food technology, biochemistry, and inorganic chemistry. Prior to joining Diamond Crystal, he was assistant to the director of the American Meat Institute Foundation, Chicago.

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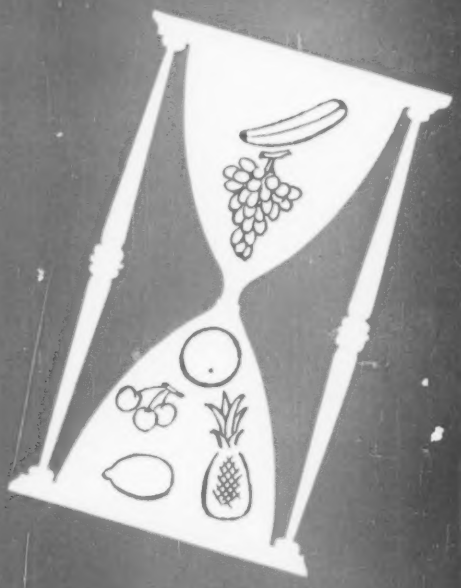

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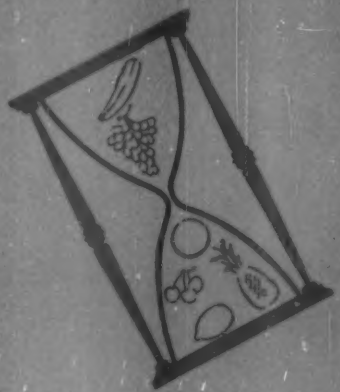

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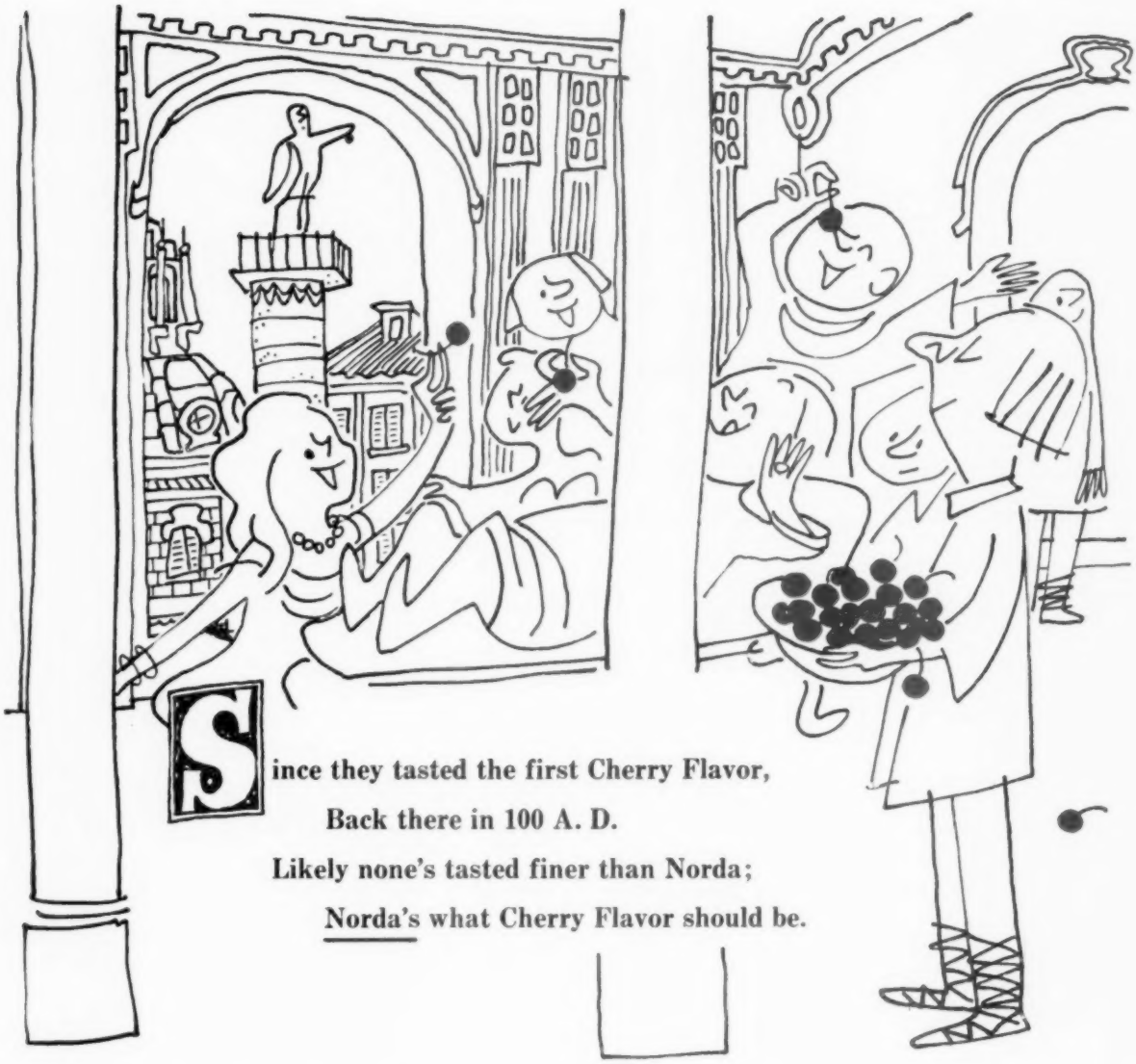

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